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SOVIET STUDIES ON GEOMAGNETIC PULSATIONS, NUMBER 2, DECEMBER 1973

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Informatics Incorporated

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This is a collection of abstracts on geomagnetic pulsations as reported in the Soviet-bloc literature from approximately 1969 to the present. Emphasis is on Pc1 phenomena, but any article relating to hydromagnetic wave propagation has been included. The material supplements Soviet Studies on Pc1 Geomagnetic Pulsations, published in July, 1973. It is given in approximate chronological order, and an author index is appended. This report also serves as the optional topic for the October 1973 monthly report on Selected Material from Soviet Technical Literature.

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INTRODUCTION

This is a collection of abstracts on geomagnetic pulsations as reported in the Soviet-bloc literature from approximately 1969 to the present. Emphasis is on Pcl phenomena, but any article relating to hydromagnetic wave propagation has been included. The material supplements Soviet Studies on Pcl Geomagnetic Pulsations, published in July, 1973. It is given in approximate chronological order, and an author index is appended.

This report also serves as the optional topic for the October, 1973 monthly report on Selected Material from Soviet Technical Literature.

Geomagnetic Pulsations

A. Abstracts

Gul'yel'mi, A. V. On the theory of the diagnosis of plasma concentration by dispersion of hydromagnetic whistlers. IN: GiA, no. 1, 1969, 169-171.

On the theory that electromagnetic oscillations in the frequency range of 0.2-5 Hz, called pearls, like whistlers, are packets of hydromagnetic waves propagated along the lines of force of the earth's magnetic field, the author suggests that these hydromagnetic whistlers be used to diagnose the concentration of a plasma in the magnetosphere. It is generally assumed that pearls are propagated along the lines of force in the form of transverse waves of the Alfven type, which have left polarization (L-waves). Measurements indicated a ratio of the carrier frequency of signals to the gyrofrequency of protons at the apex of the trajectory to be an average of $\omega/\Omega_p \approx 0.5$. This means that ω is higher than Ω_{He^+} at the apex of the trajectory. The concentrations of He^+ in the remote regions of the increment of magnetic field may be partially transformed into an R-wave in the region of space where $\omega \sim \Omega_{He^+}$. On the basis of new data it is concluded that the trajectory of pearls in the magnetosphere is a combined trajectory (Fig. 1).

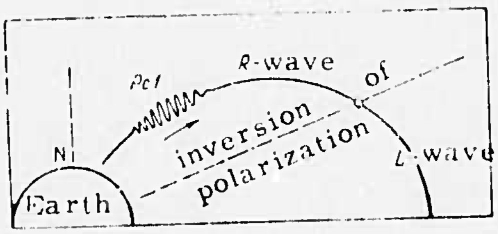

Fig. 1.

Being excited near the equatorial plane in the form of L-waves, the signal is propagated along the line of force and reaches a region where $\omega \sim \Omega_{He^+}$. Polarization inversion occurs here and the signal subsequently travels toward the earth in the form of R-waves. It is suggested that if the hypothesis is correct, then the procedure for diagnosis requires some correction. The author feels that longitudinal approximation is quite valid in the case of simple trajectories (L-waves), but with combined trajectories its applicability remains to be proved. The question of the efficiency of transformation of L-waves into R-waves also remains open.

Gogatishvili, Ya. M. Variation of the frequency of appearance of geomagnetic pulsations with the level of geomagnetic and solar activity. IN: GiA, no. 1, 1969, 181-183.

The nature of changes in the frequency of appearances v_i and the corresponding maximum amplitudes A_i of pulsations Pc3I, Pc3II, Pi1 and Pi2 is considered as a function of the level of geomagnetic and solar activity, where the initial data were microvariation recordings made at installations of Dusheti Observatory during the period 1957-1965. The mean monthly values of the frequencies of appearance of pulsations of v_i (the average monthly number of hours occupied by the pulsations, in percent) and the corresponding values of the H component of the geomagnetic field are presented. The results indicate that the velocity of the solar wind, which causes Pc3I, varies over a wider range than in the case of other types of pulsations.

Namgaladze, A. N. Observations of short-period oscillations of the geomagnetic field at Kaliningrad. IN: GiA, no. 4, 1970, 761-762.

Results from processing observations of regular short-period oscillations of the geomagnetic field, carried out at the Kaliningrad Station during 1967 with standard equipment, are presented and recordings of the H component of the geomagnetic field (sensitivity of 0.45 γ/mm and tape speed of 90 mm/hr) are analyzed. The rules governing the daily course of the frequency of appearance of Pc type pulsations coincide with those described in the literature, i.e., mainly the oscillations are observed during the day and are absent at night.

If it is assumed that the pulsations with a period typical for the given observation point are caused by toroidal oscillations of the magnetosphere, the periods of these oscillations may be used to calculate the concentration of magnetospheric plasma at the apex of the line of force intersecting the earth's surface at the latitude of the observation point

$$N = A_L T^2.$$

Coefficient A_L depends on the geocentric distance to the apex of the line of force L. For Kaliningrad Station $\Phi' \sim 51^o$, which corresponds to $L \sim 2.5\ R_E$, and in this case $A_L = 0.9$. For T = 40-50 sec, N = 1400-2200 cm^{-3}, which agrees with data on the concentration of magnetospheric plasma.

Troitskaya, V. A., and N. F. Mal'tseva. Some characteristics of the relationship of the range of IPDP to ionospheric perturbations. IN: GiA, no. 2, 1969, 310-314.

It is shown thatthe intervals of IPDP are observed during magnetic storms over periods of sharp temporal intensification of magnetic activity. It was determined from comparison with material of the Leningrad Ionospheric Station that most (97%) IPDP are observed on a background of an afternoon decrease of critical frequencies of the F2 layer; the maximum daily variation occurs when the regular E layer disappears and when the active altitudes of the F region increase. Comparison of measurements made simultaneously at stations located at conjugate points (Sogra and Kerguelen) and at stations loca d along the profile of $\lambda = 30-40^{\circ}$ E (Murmansk, Leningrad, Moscow and Rostov-na-Donu) indicate that the magnetohydrodynamic oscillations which cause IPDP arrive in the auroral zones at times of magnetic storms during periods of the greatest increase of K_p during the evening hours. The signal passes through a resonator under conditions of continuous variation of ionospheric parameters.

The ionospheric perturbations are often superimposed on the daily course of variation of ionization density, where negative perturbations accelerate the decrease of ionization density, and positive perturbations decelerate it, because they are intensified after passage of intervals of IPDP. It is also suggested that excitation of IPDP plays some independent role in heating of the ionosphere in the F2 region, because the hydromagnetic waves of these frequencies dissipate at altitudes of 150-400 km.

Al'perovich, L. S., M. N. Berdichevskiy, L. L. Van'yan and Ye. B. Kocharyants. Geomagnetic pulsations with maximum intensity at middle latitudes. IN: GiA, no. 3, 1969, 573-574.

An exception to the general rule that the amplitude of most geomagnetic pulsations decrease from north to south is discussed for a phenomenon which occurred on 1 September 1966 at approximately 14 hours UT. Most of the observation points, as seen from Fig. 1, recorded oscillations

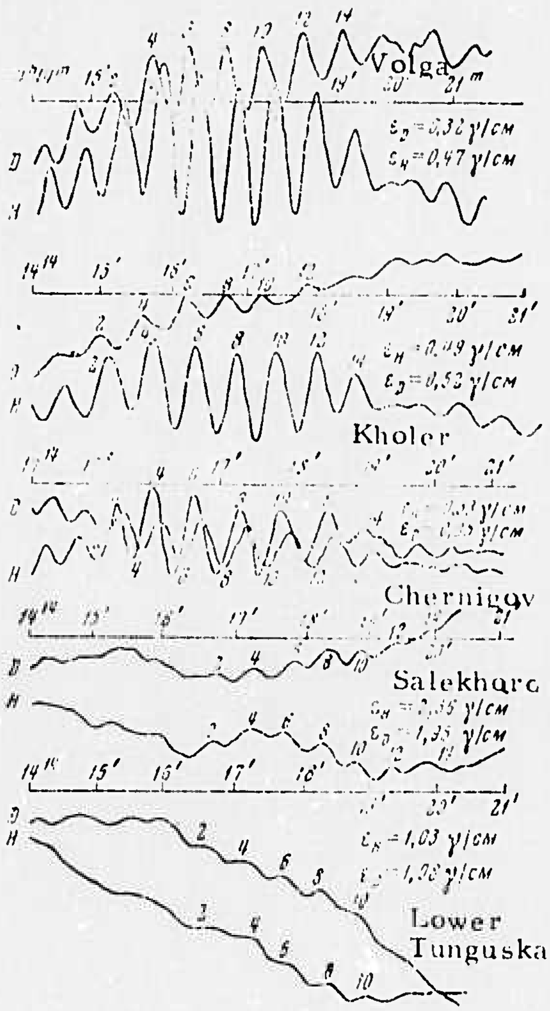

Fig. 1. Pulsations recorded on Sept. 1, 1966.

which have the form of packets of right sinusoidal shape, where the length of the packet was 7 minutes. The characteristic feature of the described oscillations is that their maximum intensity was located near $\Phi = 51^{\circ}$.

The same oscillations were tracked at only two western stations, Boulder and Fredericksburg. The Boulder observatory recorded oscillations with a visible amplitude of approximately 1 mm ($\epsilon_H = 1.5\ \gamma/\text{mm}$, $\epsilon_D = 3.1\ \gamma/\text{mm}$) on the H channel, but the oscillations were not visible on the D channel. The Fredericksburg observatory recorded a barely discernible ripple on the D channel, but there was a very clear packet of oscillations at 14 hours 15 minutes UT with a visible amplitude of 4 mm on the H channel ($H = 6\ \gamma$). The parameters of the observed oscillations are presented in the table.

Station	D, γ	H, γ	T^D_{2-4}	T^H_{2-4}	T^D_{4-6}	T^H_{4-6}	T^D_{6-8}	T^H_{6-8}	T^D_{8-10}	T^H_{8-10}	T^D_{ovg}	T^H_{ovg}
Chernigov	2,2	5,6	7"	36"	34"	37"	35"	32"	32"	33"	34"	34"
Bobruysk	2,0	5,2	5	32	31	31	34	32	31	38	33	33
Sivash	0,9	3,0	9	32	33	33	32	41	33	30	[illegible]	34
Khoper	1,4	4,7	5	27	35	35	31	35	30	32	35	32
Volga-1	1,8	5,6	7	35	36	37	40	35	33	39	36	35
Volga-2	2,1	4,1	7	28	25	37	37	33	33	30	35	32
Don	0,4	3,1	8	35	40	49	32	30	32	33	26	31
Kavkaz	0,9	2,0	33	31	35	33	35	37	30	31	33	34
Aral Sea	1,0	1,7	35	32	33	8	34	32	33	30	5	32
Urals	0,25	0,9	25	24	37	33	28	39	35	28	31	30
Salekhard	1,4	1,7	31	35	34	30	40	31	30	34	31	32
Irkutsk	0,4	0,1	32	27	34	36	32	31	34	38	38	34
Lower Tunguska	0,8	1,1	33	40	37	30	28	33	32	39	32	34

The authors suggest that the observed pulsations may be related to the resonance of the inner force tube at $Z = 2.5$. They also note that the source of the oscillations may be some fluctuations in the flow of S_q variation.

Feygin, F. Z., and V. L. Yakimenko. The mechanism of generation and development of pearls with cyclotron instability of the outer proton zone. IN: GiA, no. 4, 1969, 700-705.

The cyclotron instability of Alfven waves in a plasma with anisotropic distribution of hot protons is considered as a possible mechanism for generation of geomagnetic micropulsations of the pearl type. Assuming that the plasma is homogeneous and there is no constant electrical field, the authors calculate dependence between the wave vector k and oscillation frequency ω in the plasma by the dispersion equation

$$\mathrm{Det}(\varepsilon_{\alpha\beta} + N_\alpha N_\beta - N^2\delta_{\alpha\beta}) = 0 \quad \left(N = \frac{kc}{\omega},\ N_\alpha = N\frac{K_\alpha}{K} \right), \qquad (1)$$

where N is the refractive index of the plasma; $\delta_{\alpha\beta}$ is the Kronecker symbol and $\epsilon_{\alpha\beta}$ is the dielectric tensor. Only transverse waves, whose wave vector k is parallel (or antiparallel) to the constant magnetic field B_0, aligned along the z-axis, are considered. The cyclotron instability of Alfven waves is calculated by the exchange of energy between the waves and protons whose velocities satisfy the conditionof resonance with ionic cyclotron frequency: $v_{11} = v_1 = (\omega - \omega_i)k_z^{-1}$. It is shown that pearls should have the form of an almost monochromatic waveguide packet, whose frequency corresponds to the maximum increment. Some characteristics of the development of pearls in time are also discussed.

Gogatishvili, Ya. M. The tendency for repetition of pulsations of the geomagnetic field. IN: GiA, no. 4, 1969, 774-776.

The tendency for 27-day repetition of geomagnetic pulsations was investigated from materials from stations M'Bur, Alma-Ata and Dusheti. Recurrence of pulsations at the stations was studied for Pc3, but for Pc4, Pi1 and Pi2 only at Dusheti Station, Pc3 and Pc4 being divided into two groups: Pc3I (10-15 seconds), Pc3II (15-45 seconds), Pc4I (45-80 seconds) and Pc4II (80-150 seconds). Regarding each stormy day as zero, the total number of corresponding zero days n_0 and following stormy days n_i from $i = 1$ to $i = 35$ were calculated. The values n_i were then expressed in percentages with respect to n_o and the curves of the recurrence of pulsation storms were plotted.

The results show that the frequencies of appearance of Pc3I and Pc3II have a clear tendency toward recurrence, but those for Pc4I and Pc4II do not. The results obtained indicate the effect of Schporer's law of the dependence of latitudinal distribution of solar activity elements on the phase of the 11-year cycle. Taking into account that the period of rotation of the surface layers of the sun increase as latitude increases, it follows from Schporer's law that the intervals of 27-day recurrence should be least during years of a decline of solar activity, when the corresponding active regions are located at lower latitudes.

Van'yan, L. L., M. B. Gokhberg and L. A. Abramov. The effect of the lower ionosphere on propagation of hydromagnetic waves guided by the geomagnetic field. IN: GiA, no. 4, 1970, 719-721.

Guided hydromagnetic waves, which carry perturbations over great distances almost without attenuation, are discussed with respect to their role in the magnetosphere. The equation of the ordinary model of a thin plane ionosphere with a tensor of integral conductivity is

$$\Sigma' = \begin{vmatrix} \Sigma'_1 & \Sigma'_2 \\ -\Sigma'_2 & \Sigma'_1 \end{vmatrix}. \qquad (1)$$

Propagation of guided hydromagnetic waves in a half-space is characterized by a wave constant $k = \omega / v_A$, where the Alfven velocity $v_A = 1/\mu\epsilon$ (where μ is magnetic permeability in the SI system). A layer of isotropic dielectric of thickness h separates the ionosphere from the isotropic lower conducting half-space (earth) with a wave constant of k.

The analysis shows that the lower ionosphere (especially at night) does not introduce phase changes over a wide frequency range, and consequently does not cause a delay in propagation of perturbations from higher to lower latitudes. This requires a critical approach to analyses of the speed of propagation by the well-known formula for a homogeneous conducting medium

$$v(\mathrm{km/sec}) \quad \sqrt{5\omega / \sigma T} \tag{2}$$

(σ is specific electrical conductivity, mho/m). These analyses yield $v = 30$ km/sec for oscillations with a period of 200 seconds at $\sigma = 2 \times 10^{4}$ mho/m, i.e., to phase shifts to one-fourth of the period at distances of ~ 1500 km.

conducting medium

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Feygin, F. Z., and V. L. Yakimenko.
Fine structure of Pc 1 micropulsations.
GiA, no. 3, 1970, 558-560.

The authors attempt to explain the differences observed in the structure of dynamic spectra of pearls, without assuming changes in the emission mechanism (cyclotron instability of energetic protons).

An analysis of the factor in the expression for the magnetic field amplitude of h-m waves, which governs the change of frequency with time at $t \gg (\mathrm{Re}\,p)^{-1}$ shows the following:

If α (where $\alpha = -\partial^2\gamma/\partial k$, γ = growth rate) is constant, the slope of structural elements of dynamic spectra decreases as t^{-1}, and the spectra show a fan-shaped structure. However, in the process of quasilinear relaxation, the distribution function of energetic protons at resonant velocity can change, followed by change in γ and α. In this case α in the analyzed factor is replaced by $\tilde{\alpha} = t^{-1}\int_0^t \alpha(t')\,dt'$. In the event that $\tilde{\alpha} > \beta$ ($\beta = \partial^2\omega/\partial k^2$), then when $\tilde{\alpha}$ decreases as $\sim t^{-1/2}$ the slope does not change. If however $\tilde{\alpha}$ decreases faster than $t^{-1/2}$ the slope can even increase. As $\tilde{\alpha}$ approaches β, deviation from a fan-shaped structure diminishes, and at $\alpha \ll \beta$, the dynamic spectra have a fan-shaped structure, with the slope of structural elements decreasing as t^{-1}.

Vinogradova, V. N. Classification of micropulsations in the electromagnetic field of the Earth. GiA, no. 2, 1970, 371-373.

The activity of geomagnetic micropulsations during 1964 as well as their diurnal and seasonal variations during 1964-65 at Irkutsk are analyzed.

The relative activity of geomagnetic micropulsations during 1964 was as follows:

	Pc 1	Pc 2	Pc 3	Pc 3-4	Pc 4	Pc 5	Pi 1-2	Absent
%	3.4	2.5	50.0	28.2	3.8	1.6	6.9	3.6

The diurnal variations in occurrence rate of geomagnetic micropulsations are shown in Fig. 1.

The diurnal variation in occurrence rate of micropulsations with $T > 45$ sec has a prominent maximum at 1800-2100 hrs. LT.

The seasonal variation of Pc 3 occurrence rate is characterized by a summer maximum and winter minimum. This contradicts an earlier finding that a summer maximum is characteristic for maximum solar activity (Saito, 1965).

The seasonal variation of Pi pulsations is characterized by a winter maximum and summer minimum.

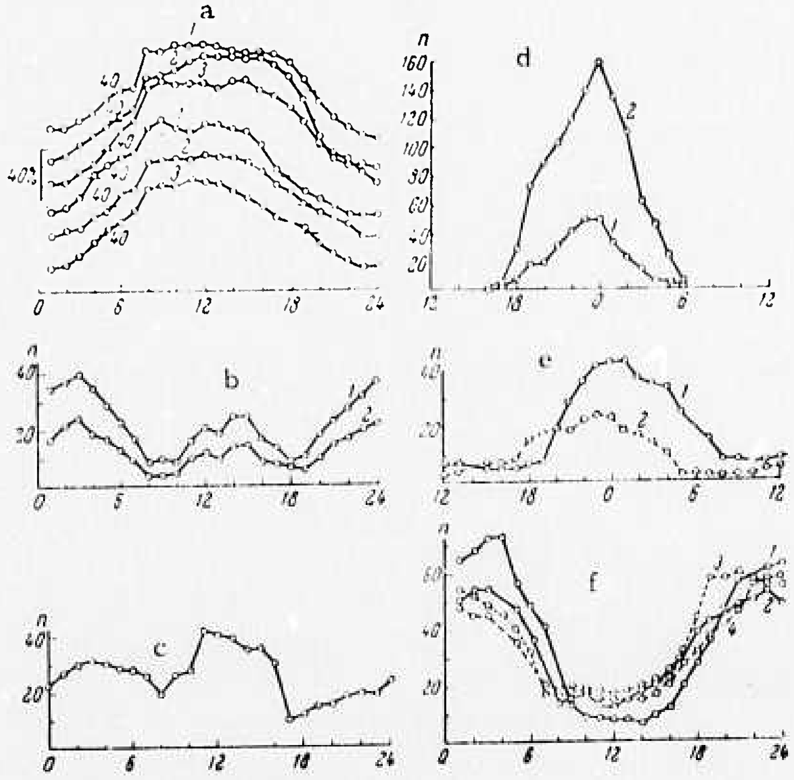


Fig. 1. Diurnal Pc variations.

a- Pc 3 (1- winter; 2- equinox; 3- summer); b- Pc 1 (1-1964; 2- 1965); c- Pc 2; d- Pi 1 and Pi 2 (1-Pi 1; 2- Pi 2); e- Pc 4 and Pc 5 (1-Pc 4; 2- Pc 5); f- Pc 3-4 (1- summer 1965; 2- summer 1964; 3- equinoxes 1964-65; 4- winter 1964-65).

Baranskiy, L. N. Some polarization characteristics of Pc 1 pulsations associated with their waveguide propagation. GiA, no. 1, 1970, 114-118.

An interpretation is given of some polarization characteristics of pearl-type pulsations consistent with their waveguide propagation. The data analyzed included records of a number of Soviet stations for 1966-67.

The horizontal projection of magnetic disturbance h approaches the magnetic meridian as the latitude of the observing point decreases (see Table 1). The explanation for this is that with approach toward the equator, angles between wave vectors and the magnetic meridian decrease due to the waveguide absorption, and consequently $h_y \rightarrow 0$.

The angle φ between the major axis of the polarization ellipse and the the magnetic meridian varies during a day as shown in Fig. 1. This is explained by the fact that the following of the morning side of the earth by

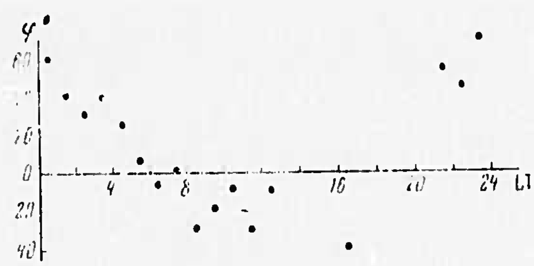


Fig. 1. Daily φ variation.

the major polarization axis indicates that pulsation sources are located there.

Table 1

Station	Φ^{o}	Average value of hy/hx for series				Average hy/hx	n
		22 March 1966	26-27 March 1966	30-31 March 1966	1-2 March 1967		
Lovozero	63	1.8	-	1.46	1.78	1.68	810
Sogra	56	1.36	0.9	1.03	1.32	1.15	2040
Borok	53	1.02	0.57	0.76	1.58	0.98	877
Shchuchinsk	44	-	-	-	0.88	0.88	334
Irkutsk (Mondy)	41	0.89	0.7	1	0.45	0.76	695

n - number of minute means

The horizontal projection of h approaches the magnetic meridian as the intensity of pulsations increases, which is observed simultaneously at stations within a wide longitude range (Sogra and Irkutsk). It is assumed that during bursts in Pc 1 intensity coherent changes in their spectral composition, and consequently in polarization, occur.

Mal'tseva, N. F., A. V. Gul'yel'mi, and V. N. Vinogradova. Effect of the westward frequency drift in IPDP intervals. GiA, no. 5, 1970, 939-941.

The azimuthal asymmetry of the evolution of spectra in IPDP's is considered. Frequency data on 30 IPDP events recorded simultaneously at Borok ($58^{\circ}02'$N; $38^{\circ}20'$E) and Irkutsk ($52^{\circ}16'$N; $104^{\circ}19'$E) during 1961-67 are analyzed.

An example of an f-t diagram is shown in Fig. 1. An analysis of the frequency data shows the following:

1. Instantaneous frequencies of pulsations are higher in Irkutsk, $\Delta f_{IB} \approx 0.24 \pm 0.13$ Hz;

2. Frequencies under consideration are observed with a delay at Borok, $\Delta t_{BI} \approx 24 \pm 12$ min. This phenomenn is called the westward frequency drift. The rate of drift is estimated to be $\Phi = 2.1^{\circ}$ min^{-1}.

3. The slope of the f-t diagrams becomes greater at Irkutsk. The differential slope is $(1.9 \pm 1.5) \times 10^{-4}$ Hz sec^{-1}.

The westward drift in frequency is thought to be due to the westward drift of the generation regions. The energy of protons is estimated, assuming that they drift with a rate of = 2.1° min^{-1}, and found to be a few tens of keV at $L \sim 5$-8.

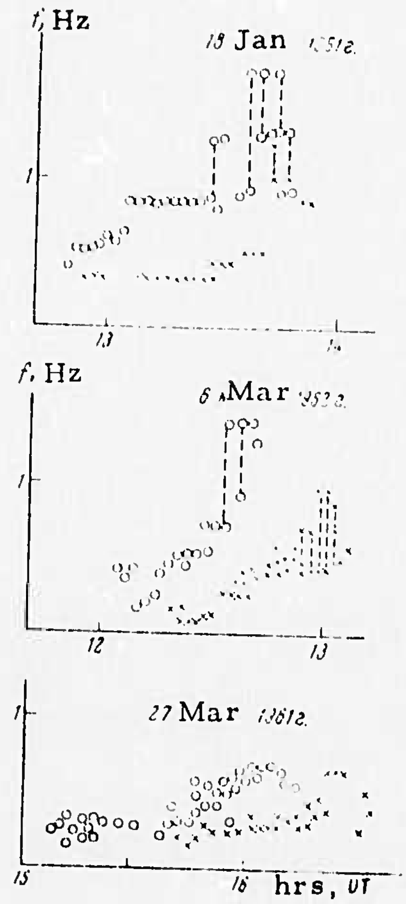


Fig. 1. Frequency-time records. Circles - Irkutsk; crosses - Borok.

Vinogradova, V. N. Variations of Pc 1 occurrence rate at mid-latitudes. GiA, no. 3, 1970, 501-504.

The diurnal, annual and solar cycle variations of Pc 1 occurrence rate at the Irkutsk station were analyzed for the period 1957-67.

The diurnal variation of Pc 1 occurrence rate (Fig. 1) is

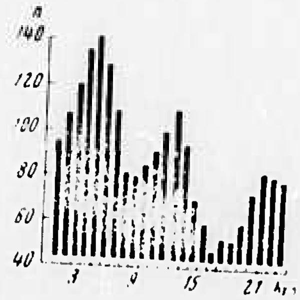


Fig. 1. Daily variation in Pc 1 occurrence, Irkutsk.

characterized by a major maximum at 0400-0600 hrs LT, and a minimum at 1600-1900 hrs. The annual variations in occurrence rate and over-all duration of Pc 1 are shown in Fig. 2, while Fig. 3 shows the

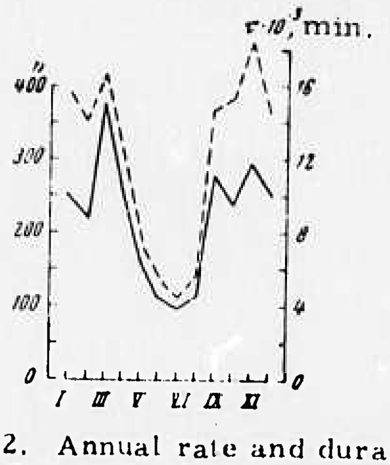


Fig. 2. Annual rate and duration of Pc 1.

solid curve - number of events
dashed curve - duration

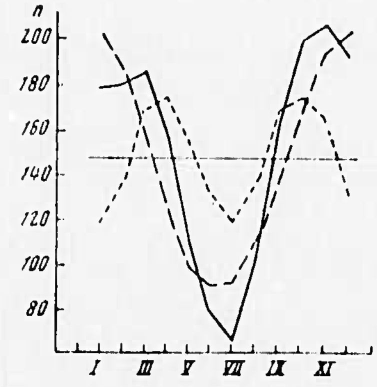


Fig. 3. Annual rate of pearl occurrence.

annual variation of the occurrence rate of well-developed pearls, and its annual and semiannual components. The annual component of the variation has a winter maximum and summer minimum, while the semiannual component has solstitial minima and equinoctial maxima.

The solar cycle variation of Pc 1 occurrence rate (Fig. 4) is characterized by a deep minimum in the years of high solar activity, and a flat maximum between the years of maximum and minimum solar activity. Predominant periods of Pc 1 pulsations during 1957-67 were 1.2-1.5 sec.

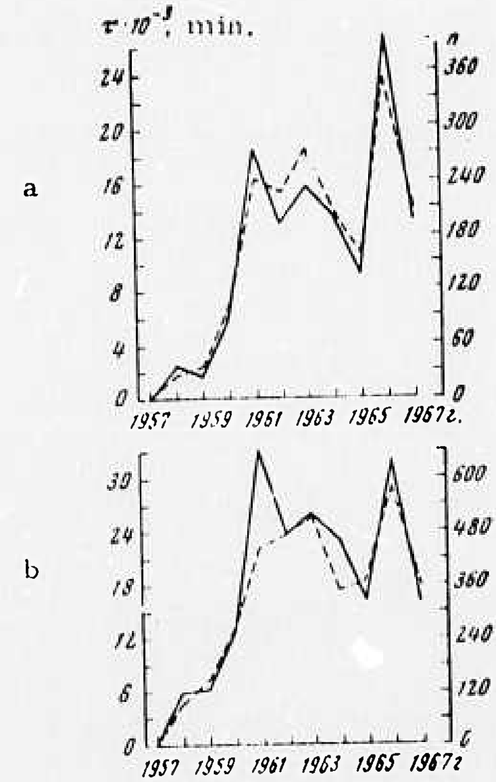


Fig. 4. Pearl behavior over the 1957-1967 interval.

Frequency (dashed) and duration (solid), of well-developed pearls (a) and all pearls (b).

Vinogradov, P. A., V. N. Vinogradova, and V. I. Gorin. Diurnal variation of the direction of polarization axis of Pc 1 pulsations. GiA, no. 3, 1970, 557-558.

A description is given of the variations in direction of the principal polarization axis of Pc 1 pulsations during evening hours at the Irkutsk station.

The type of event analyzed is illustrated in Fig. 1;

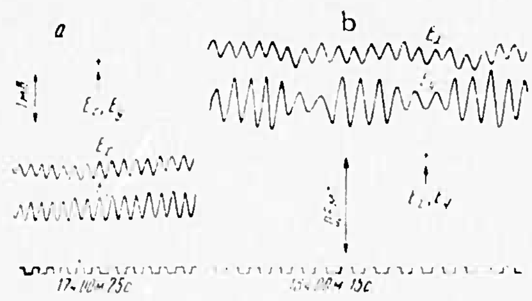


Fig. 1. Field polarization variation.

from the polarization characteristics, three intervals may be recognized as follows:

(1) Fig. 1(a), where $\Delta\varphi = \varphi e_x - \varphi e_y = 0^{\circ}$; polarization either linear or elliptical with a clockwise polarization sense; average direction of the principal polarization axis $\alpha = +34^{\circ}$ (α = angle between the polarization axis and eastward direction); (2) $\Delta\varphi = 0\text{-}360^{\circ}$; polarization nonlinear, steadily linear, or unsteadily linear; α and polarization sense change randomly; and (3) $\Delta\varphi = 180^{\circ}$; $\alpha = -9^{\circ}$, as is the case in Fig. 1(b).

The direction of the polarization axis changed in the following way:

LT, hrs:	1600 - 1630	1630 - 1700	1700 - 1730	1730 - 1800	1800 - 1815
α :	$+30^{\circ}$	$+36^{\circ}$	$+39^{\circ}$	-10	-7

Hence there exists an evening as well as morning inversion in direction of the principal polarization axis of Pc 1 pulsations.

Feygin, F. Z., and V. L. Yakimenko. <u>IPDP's as proton beam instability.</u> GiA, no. 4, 1971, 665-668.

Proton beam instability as a possible mechanism for the generation of IPDP's is considered. The dispersion equation of the transverse e-m waves in a homogenous plasma permeated by uniform magnetic field, modified by the existence of a stream of protons, is analyzed.

The dependence of the growth rate γ on the frequency ω for right-hand polarized waves (Fig. 1a) and left-hand polarized waves (Fig. 1b)

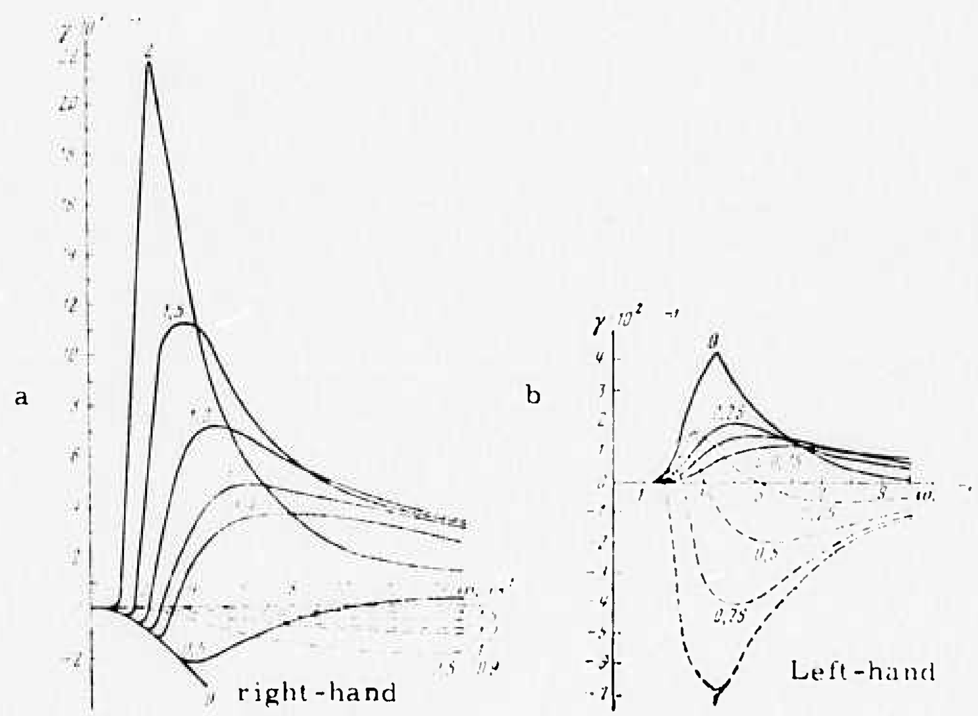


Fig. 1. γ (ω, a) where a = v_0/u; solid lines - $kv_0/w > 0$, dotted lines - $kv_0/w < 0$.

are calculated for the following plasma parameters: $n_0 = 10^2$ cm^{-3}; $n_1 = 0.1$ cm^{-3}; $u = 3.0 \times 10^8$ cm/sec; $C_A = 5.7 \times 10^7$ cm/sec; $A = 1$; and $\omega_i = 24$ sec^{-1}.

It was argued that if two opposed streams of protons originate in the magnetosphere they may generate right-hand polarized waves. The developing of the instability and quasilinear relaxation leads to a deceleration of the proton streams. A decrease of the streaming velocity v_0 leads to a change of γ and ω^0 (ω^0 is the resonance frequency). This process may be associated with IPDP's.

If $v_0 >> u$ then right-polarized waves similar to Pc1, but with a dispersion of the opposite sign and lower frequency, may be excited. As v_0 decreases, waves with increasing frequency and relatively wide frequency range (i.e. IPDP's) are excited. When streaming velocity reaches a value of $v_0 << u$ then at $A > 0$ pearl type pulsations are excited.

Gokhberg, M. B., V. N. Bogayevskiy, L. L. Van'yan and A. Ya. Povzner. The inverse problem of a magnetospheric resonator. IN: DAN SSSR, no. 6, 1971, 1308-1311.

It is demonstrated that the period related to the resonance of a standing wave may not be directly identified with the visible period of pulsations, and may be found only with the aid of simultaneous recording at conjugate points, which also permit determination of a number of magnetospheric and ionospheric parameters. The properties of a magnetospheric resonator, bounded on the northern and southern ends of the lines of force of the ionosphere - Earth system, are considered for an inhomogeneous plane wave, generated by a local source in the magnetosphere. Unlike a homogeneous plane wave, this wave takes into account the latitudinal and longitudinal gradients of pulsation amplitude, noted experimentally in a previous paper. As an example, several pairs of simultaneous recordings of magnetic field pulsations of type Pi2 at the conjugate points of Sogra and Kerguelen Island were taken, and the results of the analysis are presented in Table 1.

Table 1

Date	Time	Visible period, sec	Period of source oscillation, sec	Resonance period, sec	[illegible] sec	[illegible] Sogra	[illegible] Kerguelen
10 III 1966	20^h32^m	120	120	220	0	−0,25	0,01
11 III 1966	22^h[illegible]^m	65	65	60	5	0,55	−0,05
3 VIII 1966	9^h50^m	170	170	240	5	−0,45	−0,75
9 III 1966	20^h48^m	165	165	220	0	0,15	0,25
7 IV 1968	21^h00^m	75	75	100	0	0,2	0,3;
	17^h10^m	60	60	55	-5	0,15	0,3

The table shows that in most cases the resonance period differs strongly from the visible period, where the latter is directly determined by the period of source oscillation. The results of analysis of Pi2 oscillations show that there is essentially no resonance.

The authors feel that the resonance theory of excitation of geomagnetic pulsations is doubtful to some degree, at least for night-time conditions. It is possible to explain the pulsations by forced hydromagnetic oscillations, although their mechanism has not been adequately studied.

Gudkova, V. A., O. M. Raspopov, L. L. Van'yan, L. A. Geller, Yu. A. Kopytenko, and V. V. Privalov. Regularities in the amplitude distribution of geomagnetic pulsations over a meridional profile. GiA, no. 6, 1971, 1123-1125.

The amplitudes of Pc 3 pulsations observed simultaneously at the Belgorod ($\Phi = 45^{\circ}$), Borok ($\Phi = 53^{\circ}$), Sogra ($\Phi = 58^{\circ}$), Lovozero ($\Phi = 63^{\circ}$) and Heiss Island ($\Phi = 71^{\circ}$) stations during March-April 1968 are analyzed. Periods of the 30 events analyzed displayed a K_p dependence, but not a latitude dependence.

The distributions of the amplitude of individual Pc3 events along the meridional profile are shown in Fig. 1, and the distribution of the average amplitude of Pc3 events along the meridional profile is shown in Fig. 2. All distribution curves shown exhibit maxima at $\Phi \sim 60^{\circ}$.

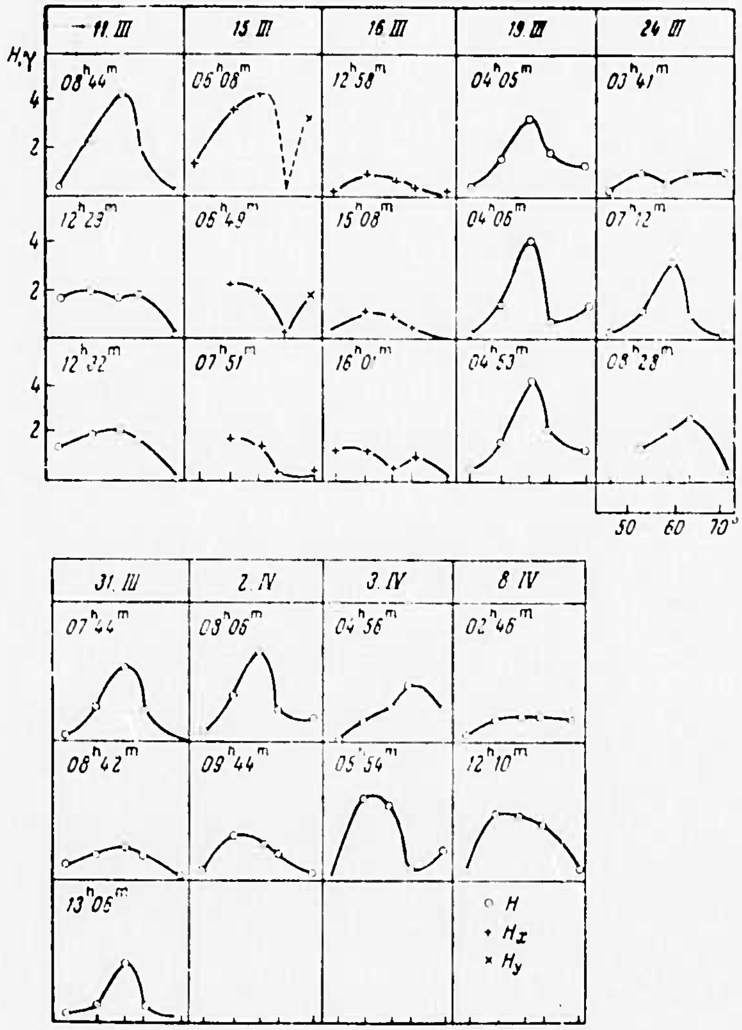


Fig. 1. Pc3 amplitude on meridional profile.

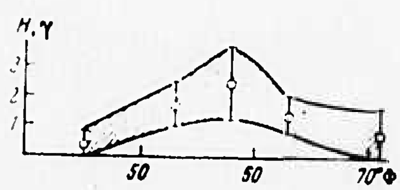


Fig. 2. Average amplitude distribution.

These results are in agreement with those of Troitskaya et al., (1968), Baranskiy et al (1969), Al'perovich et al (1969), and Eleman (1967). They do not agree with results of Voelker (1963 and 1969). The present results do not conflict with the assumption that Pc3 are generated in the magnetosphere resonator formed by the interaction of DR-currents and the plasmapause (Kopytenko et al., 1969).

The authors also note that the amplitude of Pc4 events simultaneously observed shown an increase with latitude.

Lipatov, A. S. Questions on h-m wave propagation in the terrestrial magnetosphere. IN: Trudy XV, XVI nauch. konf. Mosk. fiz.-tekhn. in-ta, 1969-1970. Ser. mat., Ch. I. Dolgoprudnyy, 1971, 81-89 (RZhGeofiz, 7/72, no. 7A297) (Translation)

An internal boundary-value problem is solved with the aid of nonstationary Maxwell equations, which describe oscillations of a magnetized plasma with the boundary conditions: 1) on the earth's surface $E_{\tau} = 0$ (a well conducting sphere); 2) in the frontal part of the magnetosphere $(\partial/\partial t + z\,\partial/\partial n)E = f$, where z is impedance and f is the source at the boundary; 3) emission of waves into the solar wind occurs at the boundary with supersonic flow; 4) the normal wave propagation velocity is constant at the boundary with a tail. As an example two cases are considered analytically: 1) excitation of waves by a point dipole, oriented normal to the magnetic field; and 2) the resonance of magnetosonic waves generated by magnetopause currents.

Kalisher, A. L., and F. T. Matveyeva. Estimate of the resonant proton diffusion from ground observations of Pc 1. GiA, no. 4, 1971, 739-741.

A tentative estimate of the pitch-angle diffusion of resonant protons is made from data on Pc 1 pulsations, obtained at the Borok and Sogra stations during 1964-65.

The pitch-angle diffusion coefficient was approximated by the formula

$$D \simeq (1\text{-}4)\, 10^{-3}\; T\; b^2 \qquad (1)$$

where $D = \sec^{-1}$, T = pulsation period, sec., and b = level in gammas.

The amplitude b of h-m waves in the equatorial plane of the magnetosphere was calculated from the amplitude of Pc 1 by the formula

$$b \simeq [(r/r_o)^{1/2}/\varkappa_1 \varkappa_2 (1-R)^{1/2}]\; b_o \qquad (2)$$

Using calculated values of $\varkappa_1 \simeq 0.1$ and $\varkappa_2 \simeq 0.5$ (after Greifinger and Greifinger, 1968; Manchester, 1966); $r \simeq 10^3$ km, $R \simeq 0.8$ (estimated from Pc 1 attenuation data) and $b_o \simeq 20$ mγ (Borok and Sogra data), it was found that $b \simeq 0.4\,\gamma$. That value, at T = 1-1.5 sec.yields in (1)

$$D = (0.2\text{-}1.0)\; 10^{-3}\; \sec^{-1}.$$

D thus estimated is of the same order of magnitude as D obtained from $D \sim t^{-1}$, where t = Pc 1 duration $\simeq (0.6 - 5.0) \times 10^3$ sec, (see Fig. 1). If the amplitude of h-m waves in the equatorial plane is estimated using the assumption $D \sim t^{-1}$, then an average value $b \simeq 0.5\,\gamma$ is obtained (Fig. 2).

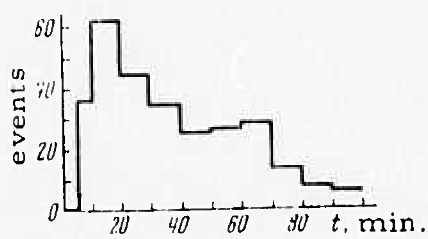


Fig. 1. n(t) of Pc 1 at Borok, periods 1-1.5 sec.

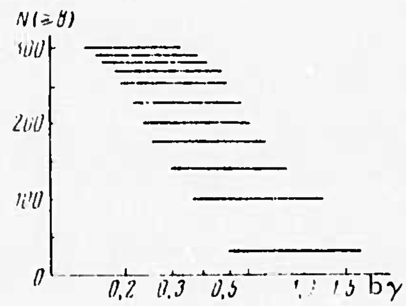


Fig. 2. Integral spread of b based on Fig. 1.

Gul'yel'mi, A. V. Magnetoacoustic channel under the plasmasphere arch. GiA, no. 1, 1972, 147-150.

The existence of a magnetoacoustic channel in the plasmasphere, as well as characteristics of guided magnetoacoustic waves, are discussed.

The necessary conditions for sustained interaction between magnetoacoustic waves and resonant particles are presumed to be fulfilled only in the plasmapause. Fig. 1 shows isolines of $n_A = c/A$ in the meridional plane, where A is Alfve'n wave velocity, Φ = latitude and R = geocentric distance in Earth radii. The figure indicates that there exists a waveguide at $L \simeq 4$, which ducts magnetoacoustic waves in the azimuthal direction.

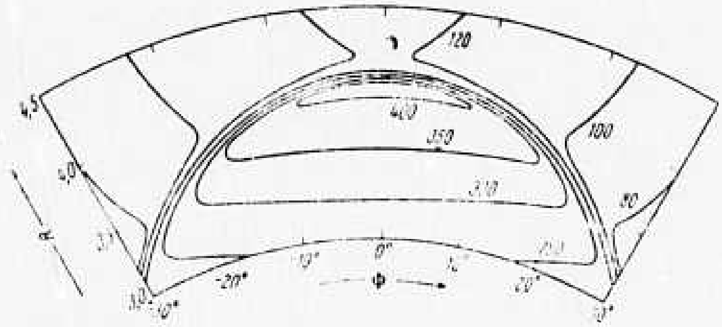


Fig. 1. Isolines of c/A in meridional plane.

Assuming a Cerenkov instability model for the generation mechanism, the author gives wave amplitude in the form

$$b^2 \cong \left(\frac{EN'}{B^2/8\pi}\right)^{1/2} \frac{p_e}{\sqrt{\Delta}}$$

where $E = m_i W^2/2$, p_e = electron pressure of cold plasma, and Δ = width of the channel in wavelengths. At values of L = 4, E = 50 keV, $N' = 0.1\ cm^{-3}$, $p_e = 10^{-9}\ erg/cm^3$, and $\Delta = 10$, the wave amplitude is $b \cong 1\gamma$ at a frequency of ~1 Hz.

In the case when waves propagate at $\theta = \pi/2$ (θ = angle between B and the wave normal) and hybrid frequency $\Omega_H = (\Omega_e \Omega_i)^{1/2}$, there appears a prominent resonance in the refraction coefficient $n^2 \cong n_A^2/(1-\omega^2/\Omega_H^2)$ (see Fig. 2). The strong frequency dependence of n^2 leads to a rapid diffusion of signals. These signals, similarly to proton whistlers, are called hybrid whistlers.

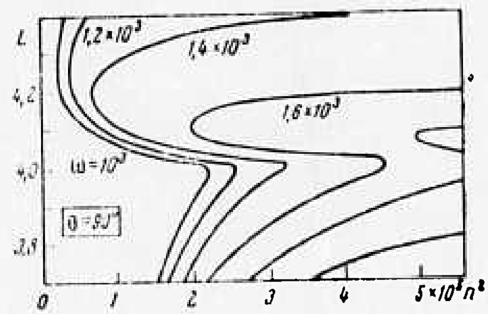


Fig. 2. Vertical profile of $n^2(L)$ for various ω.

Matveyeva, E. T., A. L. Kalisher, and B. V. Dovbnya. Physical conditions in the magnetosphere and interplanetary space during excitation of Pc 1 geomagnetic pulsations. GiA, no. 6, 1972, 1125-1127.

The relationship between Pc 1 occurrence and parameters of interplanetary space was analyzed using IMP-1 satellite data and ground observations of Pc 1 over the global network of stations (80 out of 406 3-hour intervals of observations). Diagnostics of the magnetosphere was obtained from frequency and dispersion of successive elements of about a hundred Pc 1 events, observed at the Sogra station during 1964-1969.

The dependence of Pc 1 occurrence rate on solar wind velocity, the solar wind plasma density and the vertical component of the IMF are shown in Fig. 1, a, b, c, respectively.

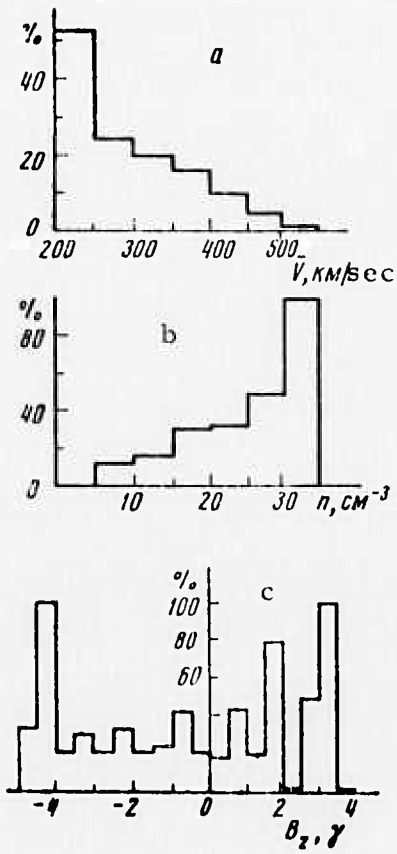


Fig. 1. Pc 1 occurrence rate vs. solar wind velocity (a), solar wind density (b), and IMF vertical component (c).

The L-value of the field lines in the region of Pc 1 excitation is found to be $L \cong 4$-8; the energy of resonant protons $\epsilon \sim 10$-30 keV; the plasma density in the region of Pc 1 excitation $N_o \simeq 1$-10 protons/cm^3.

The distribution of Pc 1 relative to the time rate of the frequency change $\xi = d \ln f/dt$ is shown in Fig. 2. Assuming that frequency

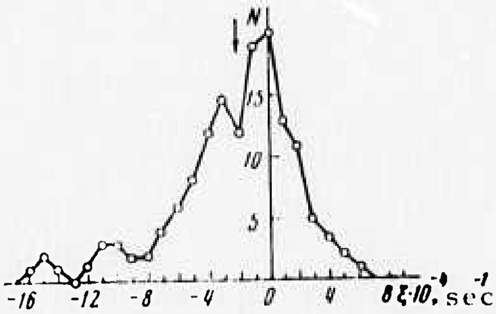


Fig. 2. Pc 1 occurrence vs. frequency change rate ξ.

decreases due to a gradual shift of the excitation region, the authors estimate that $d\ln L/dt = 3\times10^{-5}\ sec^{-1}$. They note that if the Pc 1 excitation region is located near the plasmapause, then the estimated $d \ln L/dt$ represents the time rate of the magnetosphere expansion.

Bol'shakova, O. V., and O. V. Khorosheva. <u>Zonal character of some micropulsation excitations at a geomagnetic pole.</u> GiA, no. 2, 1973, 344-346.

Recordings of geomagnetic micropulsations at high-latitude stations show series of specific pulsations, defined as specific polar excitations PD. Among those observed were intensive excitations of type PD_a with a wide frequency spectrum, which were followed by polar luminescence. PD_a excitations have definite daily and seasonal variations; their maximum occurrence is at midnight and in winter. These results were obtained from data of stations at geomagnetic latitude $\leq 77^o$ (Mirnyy, Antarctica). Similar pulsations with polar luminescence were also studied at lower latitudes $\leq 71^o$ (Kheyz Is.) in the Arctic. These excitations have a range of oscillations with T = 3-7 min, on which some irregular pulsations of period T = 10-100 sec are superimposed. A discussion is given on the locations of PD_a excitation sources. It is concluded that the cause of PD_a excitations may be oscillations of magnetosphere tail at similar periods, exciting intensity pulsations in plasma flow which penetrates the polar luminescence zone and gives rise to a powerful electrojet pulsating intensity. The authors include several sample recordings of PD_a events.

Gul'yel'mi, A. V., T. A. Plyasova-Bakunina, and R. V. Shchepetnov. Relation of the period of Pc 3, 4 geomagnetic pulsations with near-Earth space parameters. GiA, no. 2, 1973, 382-384.

Relationship of the pulsation period T (sec) is discussed as a function of magnetosphere radius R_E, solar wind velocity v (km/sec), plasma density n (cm^{-3}), doubled proton pressure P ($dyne/cm^2$) and the magnetic field B (gamma) before a shock wave front. Empirical formulas are derived for these relationships, and correlation coefficients between log T and logarithms of R_E, V, n, P and B are obtained. The relation between T and P is weak and between T and n is ambiguous, so that correlation coefficients do not sufficiently represent their close relation. Closer correlations of T(n), T(B) and T(R_E) were determined by use of a multi-factor dispersive analysis, results of which are discussed.

Preliminary results are cited of a triple-factor analysis used for evaluating relations of T and the amplitude b of Pc 3, 4 pulsations with values of B and orientation φ, θ of the IMF (φ = the angle between the projection of B on the ecliptic plane and the sun-earth line; θ = the angle between B and ecliptic plane). Calculations were done according to methods of Gringauz, Solomatina, et al (J. Geophys. Res., v. 76, 1971, 1065). For $T = T(B, \varphi, \theta)$, the common effect of all factors = 0.87; effect of B = 0.68, and the effect of associations $B\varphi$ and $B\varphi\theta$ = 0.1 and 0.09 respectively;

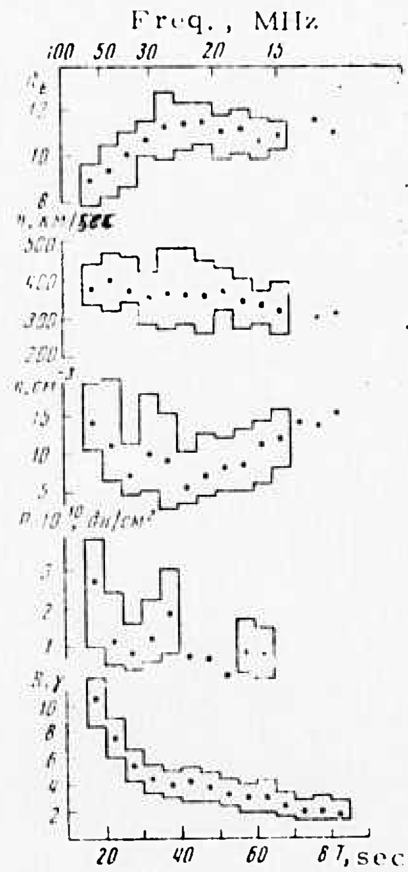


Fig. 1. Relation of T with R_E, n, v, P and B.

effects of other factors and associations were uncertain. In the case of $b = b(B, \varphi, \theta)$, the common effect of all factors = 0.78; effect of φ = 0.35, and the effect of φ θ association = 0.24; effects of other factors and associations are uncertain. Hence it appears that the pulsation period is more closely related with IMF intensity, while pulsation amplitude is more a function of IMF orientation.

Van'yan, L. L., and M. B. Gokhberg.

<u>On the excitation of magnetospheric resonators.</u>

GiA, no. 3, 1972, 492-497.

A simplified model of three-dimensional Alfven waves with straight lines of force, parallel to the z-axis and limited by two plane ionospheres, normal to the lines of force, is considered for variation of the earth's magnetic field. An expression is obtained for variations of this field from a local source, placed inside a resonator formed by the reflecting systems of the earth and ionosphere of the northern and southern hemispheres.

According to the result, magnetospheric resonance may be regarded as multiple reflections of the primary pulse between the walls of the conjugate ionospheres resonator. If there is ideal conductivity of the magnetospheric plasma, attenuation of the resonance oscillations is caused only by a single factor, namely the difference of the coefficient of reflection from unity.

The kinematic approach permits approximation of another possible cause of the attenuation, i.e. scattering of h-m waves owing to finite conductivity of the magnetospheric plasma. But the lack of data on the form of primary h-m pulses which excite such a magnetospheric resonator leaves the question unclear.

Bol'shakova, O. V., and A. V. Gul'yel'mi. Penetration of hydromagnetic waves from the magnetotail into the polar cap. GiA, no. 3, 1972, 569-571.

Preliminary results of a study on Pc2 geomagnetic pulsations at polar latitudes, using observations of the Vostok station, are described.

The K_p dependence of Pc2 occurrence at polar and midlatitudes is illustrated in Fig. 1. This dependence suggests that Pc2 pulsations are typical polar cap phenomena.

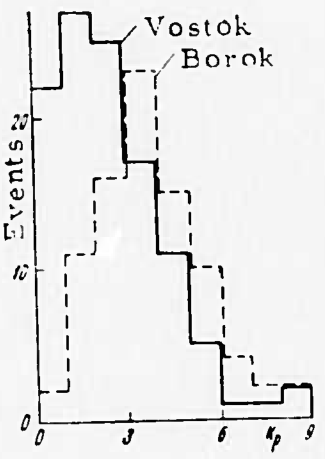


Fig. 1. Pc2 occurrence.

solid line - Vostok
dashed line - Borok

A comparison between onset times of the August 9, 1969 bursts of Pc2 and PD disturbances at the Vostok station and simultaneous micropulsations within the magnetotail detected by OGO-5 are discussed.

The reliably identified Pc2 delay and less reliably identified PD advance relative to the micropulsations detected by OGO-5 are suggested as evidence that Pc2's originate in the magnetotail as h-m waves generated by the interaction of solar corpuscular streams and the magnetosphere. Fig. 2 shows comparative recordings.

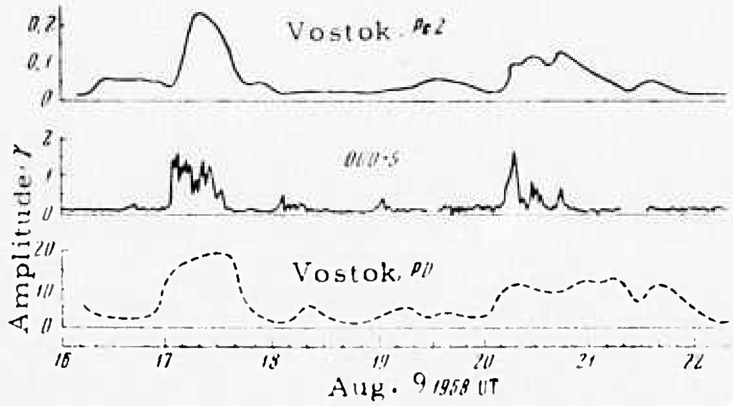


Fig. 2. Correlation with OGO-5 recordings.

Raspopov, O. M., V. A. Troitskaya, L. N. Baranskiy, B. N. Belen'kaya, V. K. Koshelevskiy, L. T. Afanas'yeva, J. Rocce, and O. Fambitokoya. Spectral properties of Pi2 geomagnetic pulsations along a meridional profile. GiA, no. 5, 1972, 892-896.

Spectral analyses of type Pi2 synchronous geomagnetic pulsations at a network of observatories, located along the meridional profile within the range of the longitudinal sector of approximately 20° (Table 1), are discussed for six cases of Pi2, recorded in March and April of 1968 under different conditions of geomagnetic perturbation (Table 2).

Table 1

Observatory	Φ	Λ	Observatory	Φ	Λ
Loparskaya	64°	115,4	Borok	53	111
Lovozero	63	116,4	Kokchetav	44	142
Kem'	60	115	Ashkhabad	30,5	130
Sogra	57,5	122	Bongi	4.8	88,5
Krasnoye Ozero	56	108,5			

Table 2

Date	Beginning, UT	K_p	A, γ	Date	Beginning, UT	K_p	A, γ
24.III	20 hr 30 min	4_-	−495	4.IV	21 hr 20 min	2	+20
27.III	19 10	3	−167	4.IV	22 01	2	−71
28.III	21 35	3_-	−276	7.IV	21 00	1_+	−20

There is a uniform variation in spectral composition of the pulsations over the meridional profile; during transition from auroral to equatorial latitudes there is a relative increase in spectral density of the maxima, corresponding to high frequencies, in the Pi2 spectra. The results are explained by the hydromagnetic instability at the inner boundary of the plasma layer, due to which there is excitation of toroidal oscillations of the lines of force which pass through the region of instability and intersect the earth's ionosphere at auroral latitudes, where the principal maxima of Pi2 amplitude is observed. The toroidal oscillations of the inner, shorter Faraday tubes may contribute considerably to the high-frequency components of the Pi2 spectrum at low-latitude stations, which explains the relative increase of the short-period components of the Pi2 spectrum in the direction of the equator.

A brief description of this same study was reported earlier (April 1973 Report, p. 139).

Koshelevskiy, V. K., O. M. Raspopov, and G. V. Starkov. Relationship of Pi2 geomagnetic pulsation parameters with processes in the auroral zone. GiA, no. 5, 1972, 886-891.

Pulsation parameters and auroral phenomena are compared on the basis of specific cases of synchronous development of both phenomena. A typical feature of Pi2 pulsations is that they are excited only in the presence of radiant forms of aurorae, although the latter are not necessarily accompanied by pulsations of this type. Some time variations of auroral forms and of Pi2 trains are shown in Figure 1.

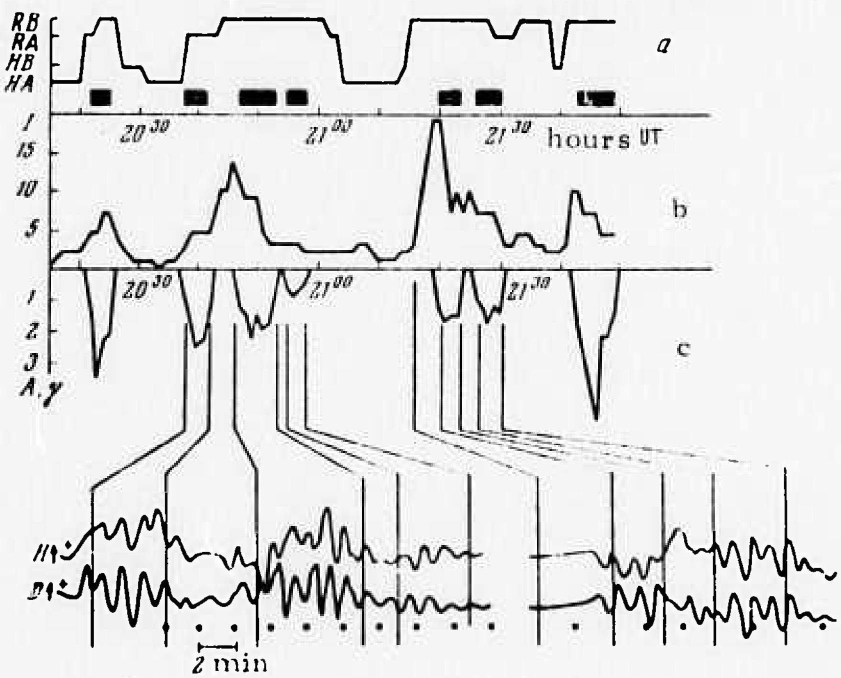


Fig. 1. Auroral Pi2 trains.

Pulsation amplitude also depends on auroral brightness. Data of magnetograms and rapid recordings of telluric currents show that a linear dependence between Pi2 amplitude and the bay-shaped perturbation is observed only at relatively low values of the latter, and then Pi2 amplitude is essentially independent of bay intensity. The Pi2 period is determined by the geomagnetic latitude of the auroral train. If there are several trains, two or more maxima may appear in the Pi2 spectrum, each of which corresponds to a specific auroral train. The authors also found that the main axis of the Pi2 polarization ellipse is located perpendicular to the auroral arc, and that synchronous variation of the direction of the arc and polarization axis is observed.

Based on the given data it is concluded that the Pi2 source is confined to the Faraday tubes of the geomagnetic field, in which active development of auroral phenomena occurs. The decrease of pulsation amplitude during intensive auroral bursts is interpreted on the basis of the flow instability mechanism of the magnetospheric plasma.

Gasse, Zh., I. A. Zhulin, F. Kambu, Kh. D. Kanonidi, N. G. Kleymenova, O. M. Raspopov, A. Sen-Mark, and Zh.-P. Treyyu. Auroral electron modulation and geomagnetic pulsations during the storm of 8 March 1970. GiA, no. 6, 1972, 1059-1066.

The results are analyzed of synchronous measurements of X-ray bremsstrahlung (with energies of more than 15 to 20 keV), made during the flight of a high-altitude drifting aerostat in Arkhangel'sk Oblast ($L \sim 3.8$), and of geomagnetic pulsations from data of Borok Observatory during the most intensive storm on 8 March 1970 (the midnight sector) during the current cycle of solar activity. During the total time of recording X-rays, intensive modulation of photon flux was noted with periods close to those of geomagnetic pulsations. Almost every variation of photon flux intensity where $T > 40$-100 sec is comparable to corresponding oscillations in the geomagnetic field, which indicates an effective mechanism of interaction of the magnetohydrodynamic waves and particles. The very high amplitude of the pulsations is apparently one of the reasons for the effectiveness of this mechanism during the storm of 8 March 1970. Modulation of auroral particle flow by MHD waves occurs both for weak (less than 10 keV) and energetic (more than 20 keV) electrons. The modulation characteristics of auroral particle flow can be deduced from considering the problem of modulation of the increment of cyclotron instability during excitation of the geomagnetic pulsation source in a localized region of the magnetosphere.

Kiselev, B. V., O. M. Raspopov, and B. I. Rezhenov. Correlation of IPDP type geomagnetic pulsations with drift of plasma irregularities in the magnetosphere. GiA, no. 1, 1973, 132-135.

The behavior of the horizontal component of the geomagnetic field during development of an IPDP interval from standard magnetograms (15-20 mm/hr) of equatorial observatories along the same equator were studied, using tellurograms of Borok Observatory with a scan rate of 30 mm/min. A positive pulse with a duration ~1 hour in the evening sector from 12:00 to 24:00 hours LT is tracked during development of the IPDP interval on magnetic field recordings of equatorial stations. At the same time no appreciable magnetic field perturbations are noted on the magnetograms of stations located in the sector of 0-12:00 hours LT. The value of the positive pulse for different cases of IPDP and different stations varies from several to tens of gammas. It was determined that there is a direct dependence between the length of the IPDP interval Δt and the length of the pulse increment ΔT. When the development of the positive pulse at different stations is compared in world time, the maximum pulse lags from station to station as it moves westward from the midnight meridian. At least three reasons are given for the possible drift of the IPDP frequency: a) variation in proton energy; b) increase of the magnetic field in the generation zone; and c) radial drift of particles.

The authors conclude that during development of a magnetic storm at equatorial distances of (5-7) R_E, corresponding to projection of the auroral zone into the equatorial plane, a proton island is formed near the midnight meridian which moves toward the west and at the same time moves in the direction of the earth under the effects of gradient drift and drift in electric fields. This motion on the earth's surface in the region of the equator is manifested in the form of a positive pulse on the magnetograms. Hence the maximum amplitude of IPDP's should be observed in the subauroral or equatorial portion of the auroral zone.

Buldyrev, V. S., A. A. Kovtun, and Pham Van Chi. Magnetosonic resonator of Pc2, 3 oscillations in the terrestrial magnetosphere. GiA, no. 1, 1973, 136-142.

It is hypothesized that part of the Pc2, 3 micropulsations, which pass simultaneously over a wide range of longitudes, occurs due to propagation of magnetosonic waves in a unique waveguide, which is the toroidal zone of the minimum Alfven velocity encircling the earth. A linearized equation of magnetohydrodynamics is used to justify the hypothesis by the parabolic equation method. Formulas are derived for the natural functions and the natural frequencies of the toroidal resonator, assuming arbitrary variation of magnetosonic wave velocity in cross-section and along the axis of the waveguide. It is shown that the spectrum of natural oscillations coincides with the Pc2, 3 spectrum, and that longitudinal field distribution and other field characteristics agree with the experimental data.

Sobolev, Ya. P. The electric field in the magnetosphere under quiet conditions, based on ground observations of atmospheric whistlers. GiA, no. 2, 1973, 379-382.

An analysis was conducted of whistlers, recorded continuously for 2 hours (12-14 hrs LT) at the Riga Station on October 16, 1965. Sonograms of two whistlers corresponding to the initial and final observation periods are shown in Fig. 1.

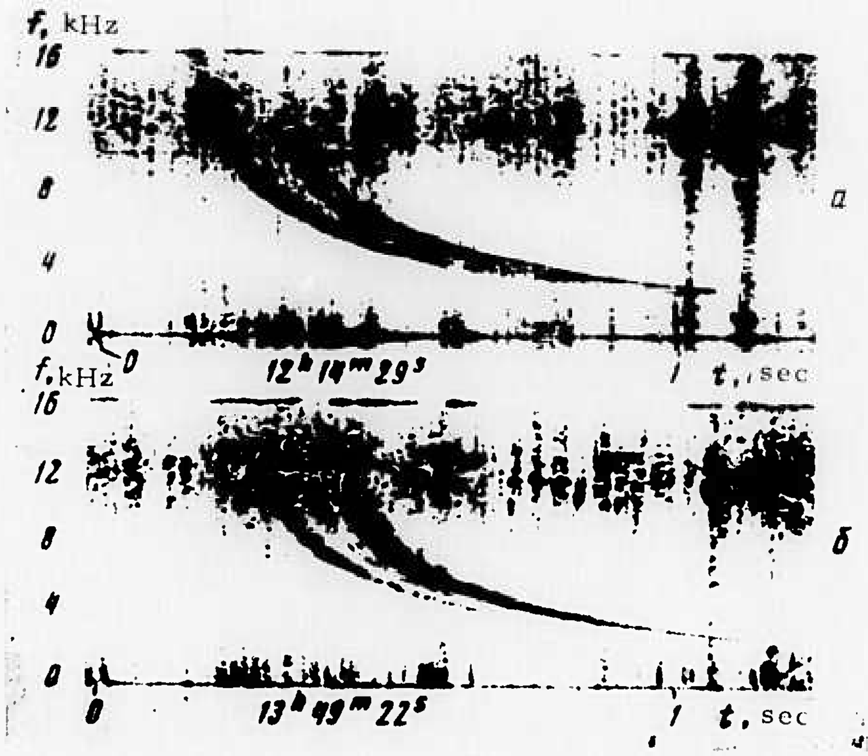


Fig. 1. Sonagrams of whistlers.

The character of the whistler was found to vary with change in channel structure. "Nose" frequency, f_n was found to vary with time, which may be connected either with magnetospheric field variations or channel drift in equatorial plane of the earth's lateral magnetic field. However, comparisons of the sonographic and previously calculated results showed that geomagnetic excitations were absent, so that f_n variations in the present case were due only to channel drift, resulting from an electric field. The time dependence of channel position is shown in Fig. 2.

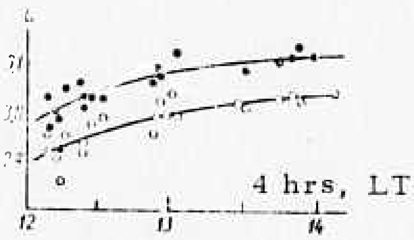


Fig. 2. Time dependence of channel position.

It is seen that channel drift occurs at variable rates, and the displacement rates of the two considered channels were same (Fig. 2: white circles represent one channel, recorded at 12 hrs 09 min 40 sec, and black - the other one, recorded at 13 hrs 49 min 22 sec). Electric fields were calculated using drift velocities for two periods of time, 12-13 hrs and 13-14 hrs. The average drift velocities for these periods were 145 m/sec (0.09 R_E/hr) and 62 m/sec (0.035 R_E/hr); and electric field - 0.17 and 0.07 mv/meter, respectively. These results are in good agreement with those of cited previous works.

Gokhberg, M. B., V. I. Karpman and O. A. Pokhotelov. The nonlinear theory of the evolution of pearls (Pc-1). IN: DAN SSSR, no. 4, 1972, 848-850.

Geomagnetic pulsations of type Pc-1 (pearls), observed in the form of packets of almost monochromatic low-frequency oscillations which are repeated within equal time intervals, are described by the dispersion relation

$$\frac{k^2c^2}{\omega^2} = \frac{\omega_p^2}{\Omega_c(\Omega_c - \omega)}, \tag{1}$$

where ω_p is theplasma frequency of cold protons and Ω_c is the cyclotron frequency. The spectral width of the wave packet, which is established before nonlinear processes leading to a decrease of the increment begin to be significant, may be calculated by:

$$e^{\gamma_L(\omega_0+\delta\omega/2)t_0} / e^{\gamma_L(\omega_0)t_0} = e^{-1}, \tag{2}$$

where t_0 is the typical time after which the nonlinear effects begin to have effect. The wave amplitude of $\widetilde{H} \approx 50$ mγ is estimated by knowing the gyrofrequency and nonlinear time τ_0. The amplitude of pulsations on the earth is $\widetilde{H}_0 = 10$ mγ, and the coefficient of passage through the ionosphere is $k = \widetilde{H}_0/\widetilde{H} = 0.2$. It is concluded that the given analysis permits description of the dynamics of development of pearls, and makes it possible to determine quantitatively some parameters of the magnetosphere and ionosphere.

Kanonidi, Kh. D. A special type of geomagnetic pulsation. GiA, no. 2, 1972, 365-366.

A new type of geomagnetic micropulsation is briefly reported. The records of one event (only four events were observed) are shown in Fig. 1.

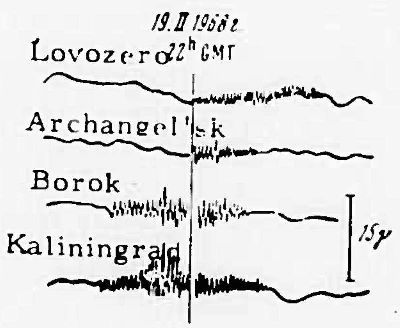


Fig. 1. Micropulsation records.

The repeated micropulsations have periods of 5-10 sec. Their amplitudes first increase and subsequently decrease; they propagate from low to high latitudes. The disturbances in the earth's magnetic field are not accompanied by disturbance in telluric currents.

The dependence of the difference in onset time of the reported events observed at different stations on the L - parameter is shown in Fig. 2.

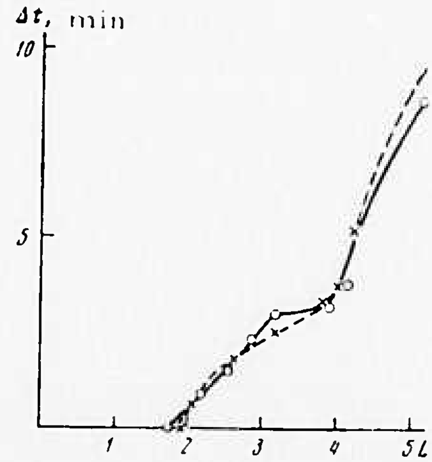


Fig. 2. Δt(L) for Feb. 19, 1968 (solid line) and Mar. 28, 1970 (dashed).

The time delays between different stations are suggested to be due to a drift of thepulsation sources across geomagnetic field lines.

The dependence of the maximum amplitude of the H-component of the reported geomagnetic disturbances on L is shown in Fig. 3. The increase in H-component amplitude at L ~ 3.8 is suggested to be controlled by the position of the magnetopause.

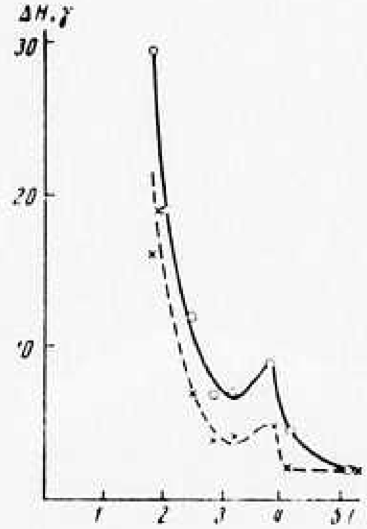


Fig. 3. ΔH(L): lines as in Fig. 2.

Antonova, Ye. Ye., B. A. Tverskoy and F. Z. Feygin. The propagation characteristics of hydromagnetic waves in a slowly varying magnetic field (approximation of geometric optics). GiA, no. 6, 1972, 1074-1081.

The propagation of hydromagnetic waves is considered along a magnetic field, varying slowly in space and time, in a plasma whose density is also a slowly varying function of coordinates and time. Only those waves in which k ‖ H are investigated, where k is the wave vector and H is the vector of magnetic field intensity. It is assumed that the plasma consists of electrons and ions of the same type and that the pressure gradient in the plasma is disregarded. Since the best examples of multiple passage of wave packets between conjugate points are oscillations of Pcl type (pearls), micropulsations of this type are discussed. Sonagrams of Pcl micropulsations, recorded at College Station on 5 September 1964 and at Sogra Station on 12 March 1968, and the negative bays recorded during the same time at Churchill and Murmansk, are presented in Figs. 1 and 2.

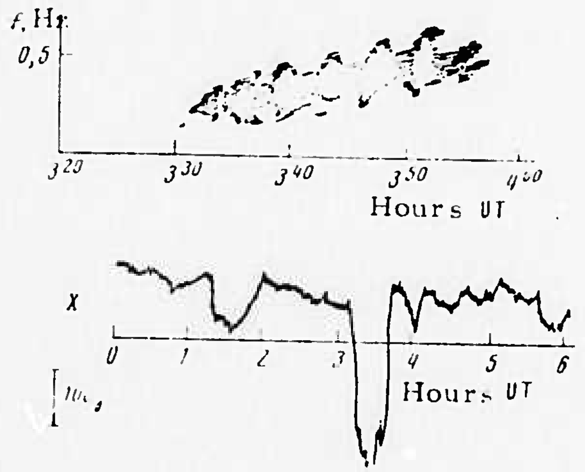


Fig. 1. Sonagrams of Pcl

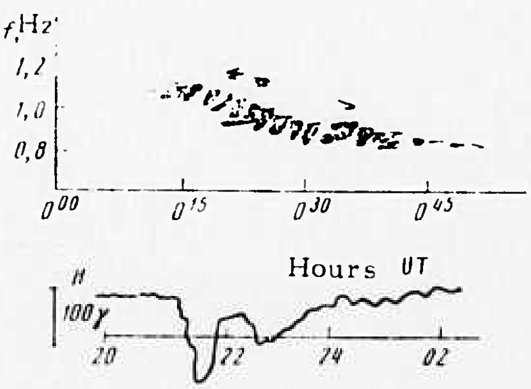


Fig. 2. Sonagrams of Pcl

The authors feel that the observed changes of the frequency spectrum of pearls with time is a result of instability of the field and density of the plasma during a substorm. It is concluded that the frequency and amplitude of a wave should vary in time even in the absence of any attenuation and oscillation of the waves.

Gul'yel'mi, A. V. and O. V. Bol'shakova. <u>Diagnostics of the interplanetary magnetic field from ground observations of Pc 2-4 micropulsations.</u> GiA, no. 3, 1973, 535-537.

A statistical method is proposed for diagnostics of the IMF from combined data on the frequency of Pc 2-4 pulsations plus K_p and AE indices. The results of diagnostics by the method proposed are compared to IMP-1 and IMP-2 satellite data on the IMF.

The diagnostics problem is reduced to determining with highest probability the correspondence between an observed set of f, K_p and AE (expressed as xj where j = 1, 2, 3) and that set of parameters which is characteristic for a certain magnitude of IMF, expressed by B index. The B index was defined in turn by dividing the magnitude range of IMF into i intervals as follows:

i	1	2	3	4	5
B, γ	22.5	2.5-4	4-6	6-8	>8

It was postulated that the set of observed parameters xj best corresponds to that B index for which

$$\chi_i^2 = \sum_{j=1}^{3} [(x_j - \mu_{ij})/\sigma_{ij}]^2 = \min \qquad (1)$$

where μ_{ij} = mean value of xj in the i-th interval, and σ_{ij} = corresponding standard deviation. An example of calculated B indices using data from Borok, Petropavlovsk and Cuba on Pc 2-4 pulsations is shown.

It was found that in 80% of the cases, calculated B indices correctly described the state of the IMF, and only in 6% of the cases did errors exceed a unit interval. In contrast, when B indices were calculated only from f, K_p or AE, the level of correct evaluations dropped to 54%, 46%, and 32%, respectively.

Kapel'zon, A. A., and I. M. Vilenskiy. On the problem of the propagation of atmospheric whistlers in the ionosphere. IN: Sb. Vopr. issled. nizhn. ionosfery, Novosibirsk, 1972, 28-31. (RZhGeofiz, 6/73, no. 6A291) (Translation)

Formulas are developed in a ray approximation for the wave field of whistlers (10^2-10^4 Hz) in the lower ionosphere. In the D-layer the wave field can reach the order of magnitude of the plasma field, and the nonlinear effect can be significant.

Aksenov, V. V. Spherical analysis of S_q variations. IN: Sb. Probl. geol. i metody geokhim. i geofiz. issled. Novosibirsk 1972, 122-130. (RZhGeofiz, 7/73, no. 7A255) (Translation)

New formulas are proposed for spherical analysis of the periodic variations whose field components are defined by orthogonal functions. The results are given of the analysis of S_q-variations during the summer of 1933 and 1958 and the equinox of 1957/58, using these formulas

The analysis shows a sufficiently good stability of the matrices in the calculation of coefficients, and a sufficiently fast convergence of expansions in the synthesis of the initial field.

Aksenov, V. V. Spherical and spatial analysis of periodic geomagnetic variations. IN: ibid., 139-149. (RZhGeofiz, 7/73, no. 7A256) (Translation)

Fundamental theorems for spherical harmonic analysis of the magnetic and electric fields of geomagnetic variations are considered. The use of an expansion for the vector potential A at the calibration condition div A = 0 is proposed. This leads to the equation $\Delta A = 0$, whose solutions are expressed through spherical functions. Expressions for external and internal fields are given, based on the coefficients of expansion of the components of the vector potential in the terms of spherical functions, expressed as a Fourier series in space coordinates. Formulas are expressed for Earth impedance and the asymptotic ratio of the magnitudes of external and internal fields for different harmonics. Analogous formulas are developed in cylindrical geometry using Bessel functions. The expansion treatment is applied to a limited portion of the Earth's surface.

Babushnikov, M. S. Geomagnetic investigations. IN: Sb. Vopr. fiz. okolozemn. prostranstva i zemn. nedr. Belorussii Minsk, Nauka i tekhn. 1972, 13-27. (RZhGeofiz 7/73, no. 7A259) (Translation)

Some results are reported on analysis of geomagnetic variations recorded at the Pleshchenitsa (Minsk) magnetic observatory during 1960-1969. Tables are given of theyearly average values of geomagnetic elements and their daily excursions, as well as plots of the yearly average values of geomagnetic indices and W numbers. The number of magnetic storms of different intensity and disturbed hours per year are reported as well.

Afanas'yeva, L. T., and O. M. Raspopov.
Characteristics of the polarization of Pi 2 pulsations in auroral and subauroral regions.
IN: Sb. geomagnit. i ionosfer. vozmushcheniya v vysokikh shirotakh, L., Nauka, 1973, 131-136.
(RZhGeofiz, 7/73, no. 7A275) (Translation)

Polarization characteristics of Pi 2 geomagnetic pulsations were studied from data obtained during simultaneous observations at stations located at auroral and subauroral latitudes during March-April 1968. Annual 24-hour records of the Lovozero station were analyzed. The results obtained verify that the behavior of the Pi 2 vector in the auroral zones differs significantly from that at mid-latitudes. There exists a diurnal variation in the polarization sense. At the Lovozero-Loparskaya latitude a considerable number of Pi 2 events with mixed polarization were registered. In transition from subauroral to auroral latitudes, a change in the polarization sense may occur.

Raspopov, O. M. Development of geomagnetic pulsations during a substorm. IN: Issledovaniya po geomagnetizmu, aeronomii i fizike solntsa, no. 23, 1972, 235-245.

A description is given of the development of a substorm in geomagnetic pulsations. The concept of the pre-breakup, breakup and recovery phases of a substorm is accepted in this analysis.

It was found that the pattern of micropulsation generation during the prebreakup phase does not depend on the intensity of the magnetic disturbance. However, during the breakup and recovery phases, the micropulsation pattern for the conditions of weak magnetic disturbances ($K_p < 3$) differs from that for moderate and great magnetic disturbances ($K_p \geq 3$).

A schematic representation of the generation of geomagnetic micropulsations during the pre-breakup phase is shown in Fig. 1.

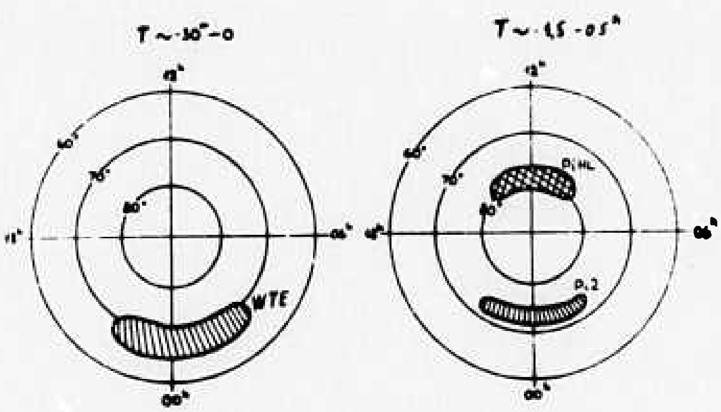


Fig. 1. Diagram of the generation of geomagnetic pulsations during the pre-breakup phase of a substorm.

As seen in Fig. 1, at the onset of pre-breakup phase (T~ -0.5 to -1.5 hrs) in the midday sector, Pi HL pulsations (long-period high-latitude pulsations according to Troitskaya et al., 1972) are generated within the polar cap. The region of their generation is located near the projection of the daytime cusp of the magnetosphere. In the midnight sector bursts of Pi 2 are observed, which are associated with increase in brightness of quiet auroral arcs and their drift towards the equator. The region of Pc 2 generation coincides with the projection of the equatorward boundary of the nighttime cusp. Later on, at T~ -30 to 0 min, in the midnight sector WTE (whistler type emissions according to Kato, 1969) are generated, which are also associated with equatorial drift of auroral arcs.

A schematic representation of the micropulsation pattern during the breakup and recovery phase for $K_p \geq 3$ and $K_p < 3$ are shown in Figs. 2 and 3.

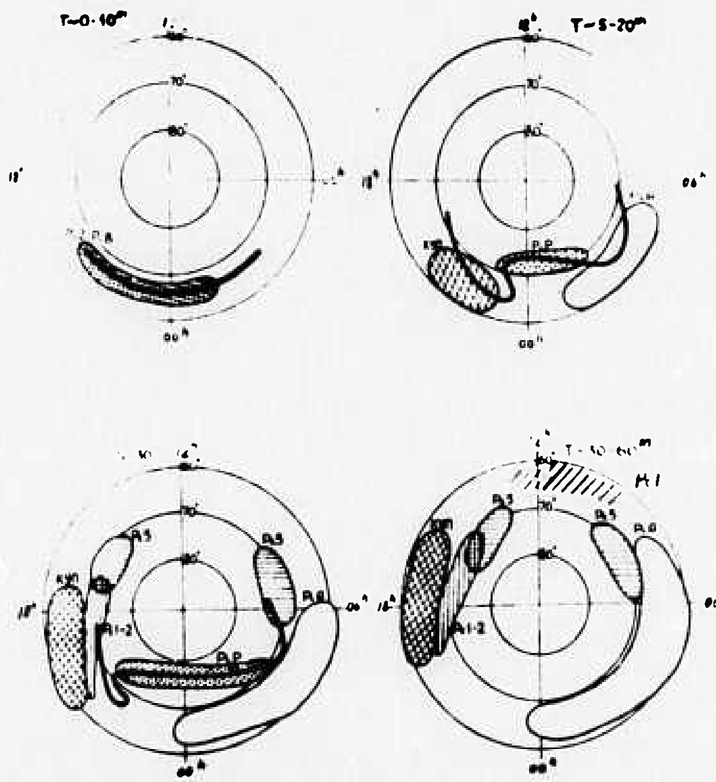


Fig. 2. Diagram of the generation of pulsations during breakup and recovery phases of a substorm, under conditions of moderate and great disturbances ($K_p \geq 3$). (KYП ≡ IPDP)

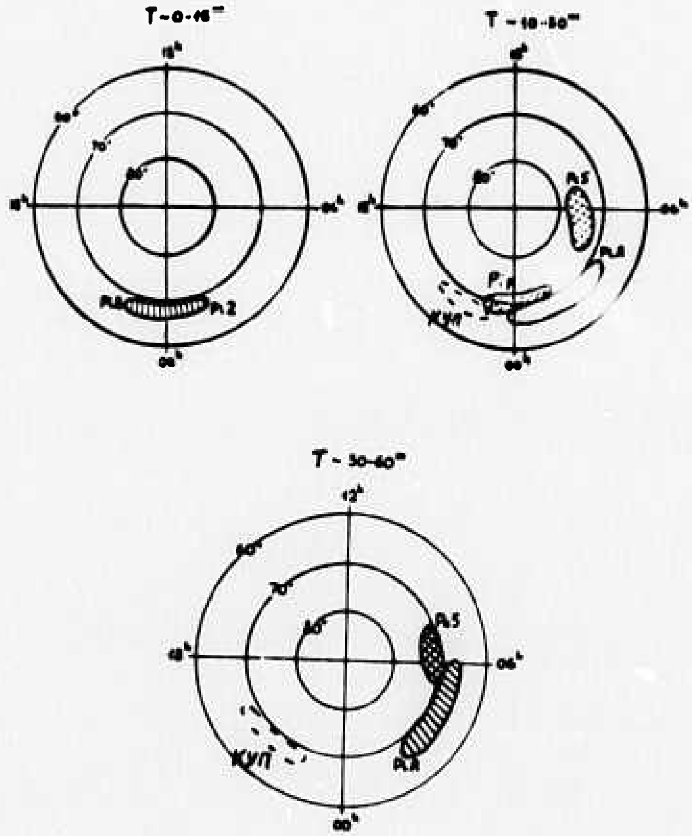


Fig. 3. Diagram of the generation of pulsations during breakup and recovery phases, under conditions of weak disturbances ($K_p < 3$) (КУП ≡ IPDP)

It is emphasized that the indicated regions of micropulsation generation have only an approximate character, since their size and location depend strongly on the substorm intensity and the state of the geomagnetic field.

Zelenkova, L. V., I. N. Men'shutina, and M. I. Pudovkin. Two types of geomagnetic pulsations at the polar cap. GiA, no. 5, 1973, 955-958.

The characteristics of geomagnetic micropulsations above the polar cap are analyzed using observations of the Mirnyy station ($\Phi \cong 77^{\circ}$) during 1960-1962.

The analysis identified two regimes of geomagnetic pulsations: a daytime one which is characterized by prevailing pulsation periods of $T < 10$ min, which do not exhibit a dependence on geomagnetic activity (AE-index); and a nighttime regime with $T \geqslant 10$ min, which does exhibit a dependence on the AE-index (see Fig. 1).

The surface waves in the magnetopause are suggested to be a generation mechanism of daytime pulsations, while the h-m resonance in the magnetotail is suggested as a generation mechanism of nighttime pulsations.

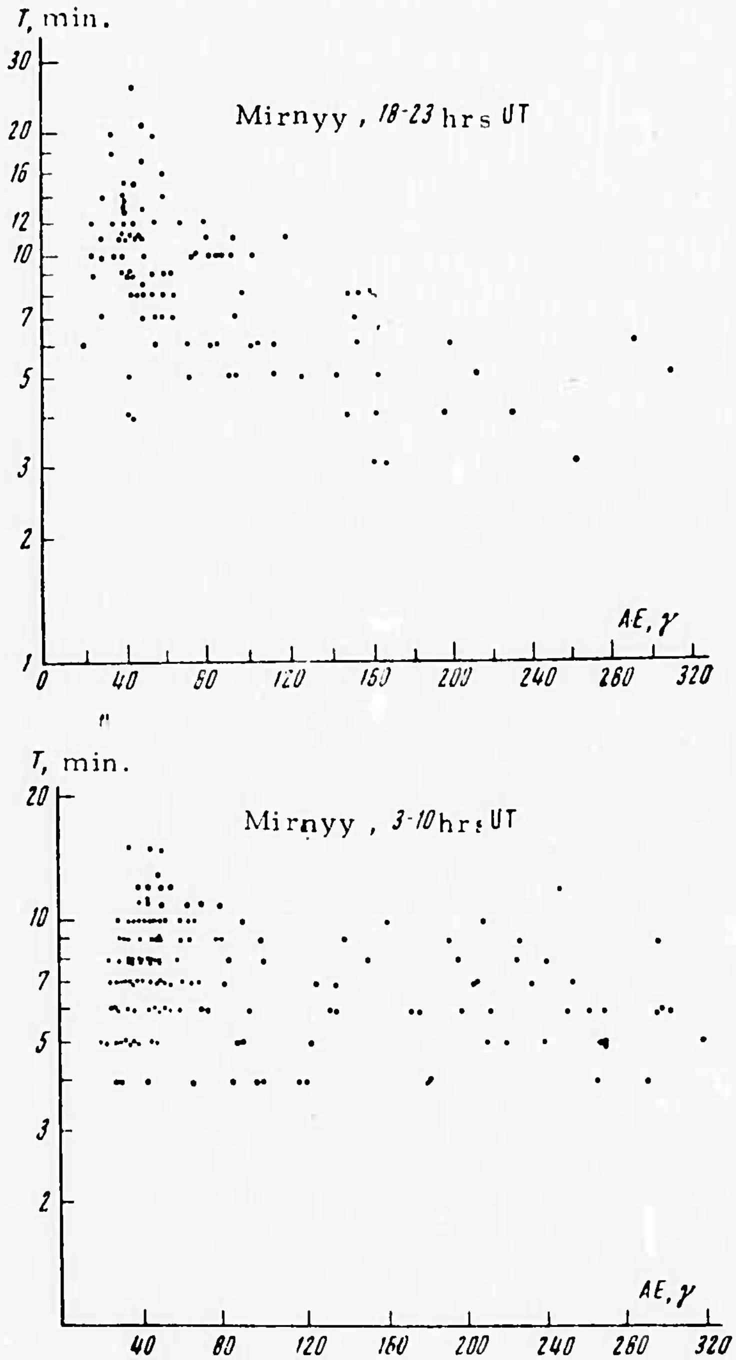


Fig. 1. Dependence of the period T of daytime and nighttime pulsations at Mirnyy on AE index.

Van'yan, L. L., L. M. Zelenyy, A. A. Kozhevnikov, and V. A. Yudovich. Hydromagnetic waves in a plasma with finite conductivity. GiA, no. 4, 1973, 730-734.

The structure of hydromagnetic wave flux from an electric dipole type source, grounded in the magnetospheric plasma, is investigated theoretically, with consideration of the finite value of conductivity along the lines of force of the geomagnetic field. An expression is derived for the total flux passing through the half-space $x > 0$ for any z-direction value. Another expression is obtained for the specific case where $kz \gg 1$, showing that the amplitude of total flux decreases at large distances as $z^{-1/2}$. The authors give a numerical example using the model of Fig. 1 for opposed flux directions. For some typical assumed

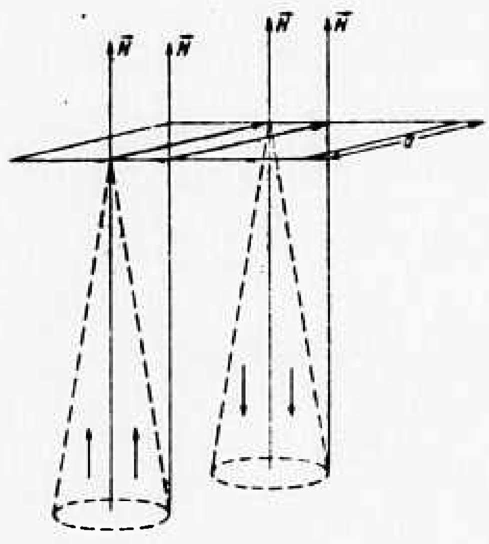


Fig. 1. H-m flux model.
a = axial separation of opposed flows.

parameters it is shown that for magnetospheric sources up to 200 km or more in size the propagation cones of Fig. 1 do not intersect, hence all longitudinal flux developed by the source escapes to the ionosphere. It is concluded that the smaller the dimensions of the source, the more pronounced is the effect of finite conductivity.

Hollo, L., M. Tatrallyay, and J. Vero. Experimental results with characterization of geomagnetic micropulsations. I. Methods of characterizations used in the investigations. IN: Acta Geodaetica, Geophysica et Montanistica, T. 7, 1972, 155-166. (in English)

A semi-quantitative method for characterization of micropulsation activity used at the Nagycenk Observatory in Hungary is presented. An index is defined which is a measure of the occurrence rate of geomagnetic micropulsations.

Hollo, L., and Y. Vero . Experimental results with the characterization of geomagnetic pulsations. II. Micropulsation index. Auto-and cross-correlation functions of micropulsations and geomagnetic activity. IN: ibid., 167-175.

A correlation analysis was carried out using the micropulsation index (as defined in Part I foregoing) and geomagnetic index ΣT. The results indicate that, in addition to an immediate effect, there exists an after-effect of the geomagnetic activity upon micropulsation activity. This appears 2 to 5 days after geomagnetic disturbances.

Vero , Y. Experimental results with the characterization of geomagnetic micropulsations. III. Effect of the geomagnetic activity on Pc 3-4 and Pi-2 type geomagnetic micropulsations. IN: ibid., 177-190.

The relationships between Pc 3-4 and Pi 2 occurrence rates and geomagnetic activity are analyzed. It was found that the occurrence of

Pc 3-4 (15-40 sec period range) depends strongly on geomagnetic activity, whereas the occurrence of Pi 2 (40-240 sec period range) was found to be independent of geomagnetic activity.

Lyatskiy, V. B. Interpretation of pearl-type pulsations by Cerenkov radiation from proton bunches. IN: AN SSSR. Polyarnyy geofizicheskiy institut. Geofizicheskiye yavleniya v avroral'noy zone (Geophysical phenomena in the auroral zone). B. Ye. Bryunelli (ed.) Leningrad, Izd-vo Nauka, Leningradskoye otdeleniye, 1971, 141-155.

An interpretation of general and specific features of the activity of pearl-type pulsations is presented, based on the Cerenkov radiation model of their generation (Bryunelli and Lyatskiy, op. cit., 137).

The Cerenkov radiation model explains well a number of the characteristics of pearl-type pulsations such as:

a) amplitude and period range;

b) latitude dependence of the average period;

c) narrow frequency band;

d) fine structure: discreteness, pattern repetition and parallelism of the structural elements of dynamic spectra;

e) correlation between emission period and pattern repetition period (see Fig. 1);

f) equal frequency and alternate occurrence of emissions at the conjugate points;

g) slow increase in amplitude after initial appearance, and subsequent slow decrease within individual structured elements of a series and recurrence of series with similar emission and pattern repetition periods, with recurrence period of 1-3 hours (see Fig. 2).

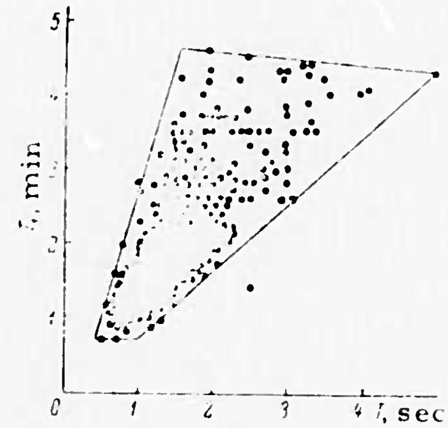


Fig. 1. Correlation between pattern repetition periods t_1 and emission periods t for pearls at Lovozero, Jan. 1962-May 1964.

Fig. 2. Correlation between recurrence period t_2 and oscillation period T for recurrent series of pearls (at least three times) with similar emission and pattern repetition periods.

It is pointed out that the assumption of the existence of stable proton bunches in the magnetosphere is a weak point of the Cerenkov radiation model. The model associates the emission period with gyration motion; pattern repetition period with bouncing along field lines joining the conjugate mirror points; and recurrence period with drift around the Earth.

Mal'tsev, Yu. P. Propagation of hydromagnetic waves in the Earth's magnetosphere and ionosphere. IN: ibid., 173-182.

An analysis was carried out of the polarization characteristics of hydromagnetic waves as they propagate from the equatorial region of the magnetosphere to the Earth's surface, where they are detected as pearl-type geomagnetic micropulsations. The analysis was performed to find an explanation for the fact that observed pearl pulsations have a predominant right-hand polarization, whereas all models for their generation mechanism assume a left-hand polarization of primary wave packets.

The analysis shows that h-m waves with a left-hand polarization. originating in the equatorial plane of the magnetosphere, reach the ionosphere as linearly polarized h-m waves. As they are further guided and transmitted through the F_2- and E-regions they split into two elliptically polarized modes. As calculations show, the left-hand mode attenuates much more strongly in the lower ionosphere (~100 km region) due to high gyrotropy, and most frequently only the right-hand mode reaches the Earth's surface. Calculations were made using the ionospheric model according to Al'pert et al., 1967. (Rasprostr. e-m voln v volnov. Zem-ionosph. M., Nauka, 1967, 141) A table listing ionospheric parameters obtained over the 10^{-2} - 10 rad/sec range is included.

Sedova, F. I. Some characteristics of Pc 1 occurrence at midlatitudes. IN: Sb. Geofiz. issled. territorii Ukrainy Kiyev, Nauk. dumka, 1972, 8-14. (RZhGeofiz, 7/73, no. 7A271) (Translation)

Regularities in Pc 1 occurrence are analyzed according to observations of telluric currents at Korets and Odessa stations, which are separated by 4^{o} in latitude and 7^{o} in longitude. The regularities in Pc 1 occurrence according to observations at both points agree, in the main, with data from other stations. Most Pc 1 events were recorded at both stations, however the times of their starts and finishes do not always coincide, and the disagreement in the onset time varies from several minutes to several hours. The periods of Pc 1 envelopes rarely agree at both stations. Pc 1 pulsations occur only at one point relatively frequently. The distribution of Pc 1 observed only at Odessa gener: ly follows the distribution of Pc 1 observed at both points, while Pc 1 observed only at Korets occur during years in which they are infrequent at Ode sa. In 1968 Pc 1 occurred only at Korets, in which case their periods were about 4-6 sec; when occurring at both stations, periods were 10-15 sec. Pc 1 occurrence is strongly influenced by local conditions.

Gorbachev, L. P., and Yu. N. Savchenko. Propagation of a hydromagnetic pulse in the ionospheric waveguide. Geomagnetizm i aeronomiya, no. 1, 1972, 71-76.

The propagation of a hydromagnetic pulse in a cold plasma waveguide permeated by a static magnetic field B_o is considered. The Alfve'n wave velocity in the waveguide is approximated with the required accuracy. The phase and group velocities as well as the time derivative of the vertical component of magnetic disturbance b of h-m waves are calculated for the ionospheric parameters chosen to correspond to the nighttime at sunspot minimum (according to Tepley and Yandshoff, 1966).

The ionospheric model is shown in Fig. 1. Two non-conducting

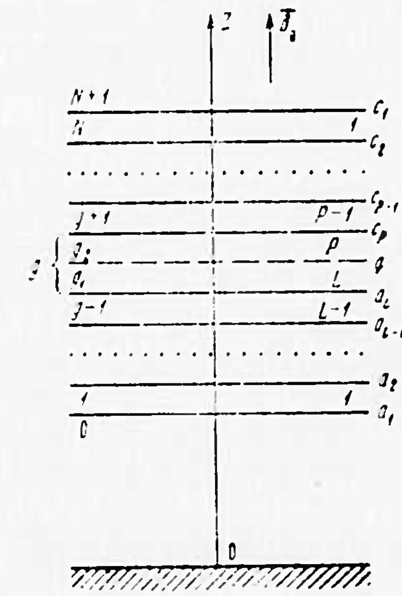


Fig. 1. Ionosphere model.

regions at $z < a_1$ and z c_1 and a perfect conductor at $z = 0$ are assumed. The distribution of the Alfve'n wave velocity is approximated by a homogeneous N- layered model, where N is an arbitrary number.

The expressions for the electric field strength E and induced magnetic field b are derived, assuming that an ideally conducting sphere originates in the g layer ($1 \leq g \leq N$) at the point $z = 2$ ($a_L < q < c_p$) at $t = 0$. Its radius changes according to an arbitrary law $R(x)$, but max $R(t) = \rho < c_p - a_L = h$.

The phase and group velocities of h-m waves calculated for $N = 2; l = 1 = L; p = 1, 2 = P; a_1 = 3; c_1 - c_2 = 2; S_{P=1} = 0.8; h = 100$ km, Vag = 400 km/sec are shown in Fig. 2.

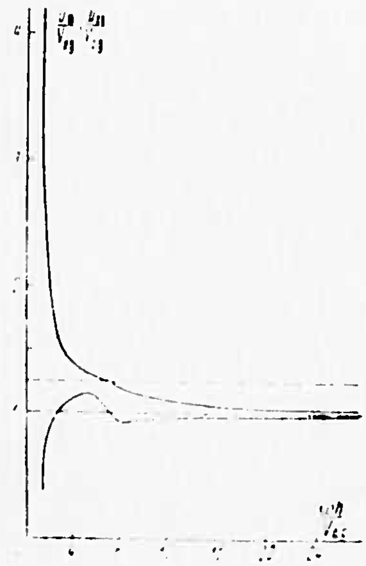


Fig. 2. Phase and group velocity characteristics.

upper curve - phase velocity
lower curve - group velocity

The time derivative from the vertical component of the magnetic disturbance calculated for the above ionospheric parameters and $q = 3.25$; $z = 0.5$; $r = 100$; $m = 7$; $\tau = 4$; and $\rho = 0.25$, is shown in Fig. 3.

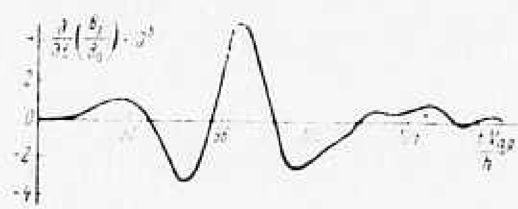


Fig. 3. Time derivative of pulsed field.

The results obtained are in an agreement with the observations made during the Argus-III ionospheric nuclear explosion.

Strestik, J. Pi2 pulsations resolved into a superposition of sinusoidal oscillations. Studia geoph. et geod., no. 1, 1971, 64-75.

A method is developed for resolving an irregular oscillation into a sum of sinusoidal oscillations. The method is based on the successive subtracting of the spectra of sinusoidal oscillation with appropriate frequencies, amplitudes and phases from the spectrum of the irregular oscillation in question, until the residue is a spectrum of a non-periodic function. This method was applied to analysis of Pi2 pulsations recorded at the Budkov station during 1963.

The author found that Pi2 pulsations are usually composed of 3 to 6 sinusoidal oscillations (see Fig. 1), most of them originating from frequency modulation of Pi2 pulsations.

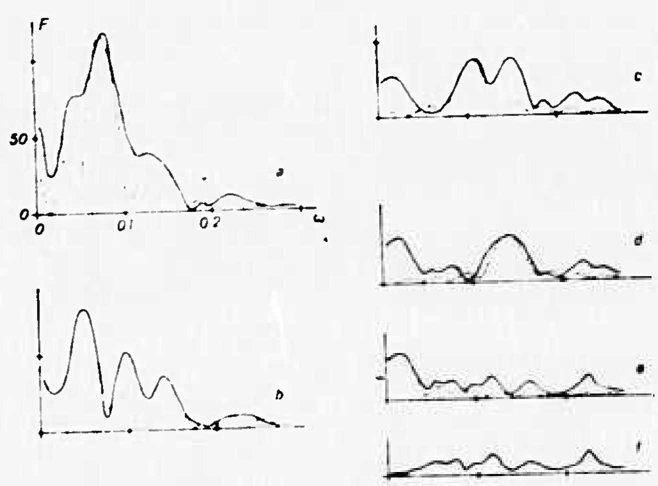


Fig. 1. Real spectral density of Pi2 pulsations before (a) and after (b-f) successive subtracting of spectra of sinusoidal oscillations (dashed curves of a-e).

Bochanicek, J. Propagation of h-m waves with periods corresponding to periods of Pcl micropulsations through the lower ionosphere. Studia geoph. et geod., no. 1, 1972, 60-67.

The vertical propagation of h-m waves at Pcl frequency was studied for the models of daytime quiet, daytime disturbed with E_s - layer and nighttime quiet lower ionosphere in the midlatitude region (Models 1, 2 and 3 in Table 1). The electric field intensity of h-m waves as a function of height above the Earth and frequency was calculated using an approximation of the equations of small hydromagnetic waves derived by Bochnicek (1967; 1968). A solution was found for boundary conditions obtained under the following assumptions: a) the thickness of the neutral atmosphere is negligible; b) the lower boundary of the lower ionosphere contains a thin homogeneous layer; c) multiple reflections from the Earth's surface are negligible; d) Earth is planar, finitely conducting and electrically homogeneous; and e) the electric field intensity of h-m waves at the Earth's surface has a unit magnitude.

The electric field intensity of clockwise and counterclockwise h-m waves as a function of T[s] and z [km], calculated for different ionospheric models is shown in Figs. 1-3.

Table 1.

h [km]	Model 1, 2 z	Model 3 z	Model 1 n [cm^{-3}]	Model 2 n [cm^{-3}]	Model 3 n [cm^{-3}]	Model 1, 2 m_i [g] $\cdot 10^{+23}$	Model 3 m_i [g] $\cdot 10^{+23}$	Model 1, 2, 3 ν_{en} [s^{-1}]	Model 1, 2, 3 ν_{in} [s^{-1}]	Model 1, 2, 3 B_0 [gauss]
65	0	—	$5{\cdot}60 \times 10^{1}$	$5{\cdot}60 \times 10^{1}$	—	—	—	$1{\cdot}47 \times 10^{7}$	—	0·483
70	5	—	$1{\cdot}67 \times 10^{2}$	$1{\cdot}67 \times 10^{2}$	—	—	—	$1{\cdot}86 \times 10^{6}$	—	0·482
75	10	—	$2{\cdot}78 \times 10^{2}$	$2{\cdot}78 \times 10^{2}$	—	—	—	$3{\cdot}17 \times 10^{6}$	—	0·481
80	15	0	$3{\cdot}89 \times 10^{2}$	$3{\cdot}89 \times 10^{2}$	$1{\cdot}00 \times 10^{1}$	—	—	$1{\cdot}47 \times 10^{5}$	—	0·480
85	20	5	$5{\cdot}00 \times 10^{2}$	$5{\cdot}00 \times 10^{2}$	$6{\cdot}25 \times 10^{1}$	—	—	$6{\cdot}84 \times 10^{5}$	—	0·479
90	25	10	$5{\cdot}00 \times 10^{3}$	$6{\cdot}70 \times 10^{4}$	$1{\cdot}15 \times 10^{2}$	4·849	4·849	$3{\cdot}17 \times 10^{5}$	$9{\cdot}00 \times 10^{3}$	0·473
95	30	15	$9{\cdot}50 \times 10^{3}$	$1{\cdot}33 \times 10^{5}$	$1{\cdot}67 \times 10^{3}$	4·849	4·849	—	$4{\cdot}80 \times 10^{3}$	0·477
100	35	20	$1{\cdot}60 \times 10^{5}$	$2{\cdot}00 \times 10^{5}$	$2{\cdot}20 \times 10^{3}$	4·849	4·849	—	$2{\cdot}40 \times 10^{3}$	0·476
105	40	25	$1{\cdot}93 \times 10^{5}$	$5{\cdot}00 \times 10^{5}$	$1{\cdot}49 \times 10^{3}$	4·693	4·693	—	$1{\cdot}10 \times 10^{3}$	0·475
110	45	30	$2{\cdot}22 \times 10^{5}$	$2{\cdot}22 \times 10^{5}$	$1{\cdot}26 \times 10^{3}$	4·636	4·636	—	$5{\cdot}30 \times 10^{2}$	0·474
115	50	35	$2{\cdot}33 \times 10^{5}$	$2{\cdot}33 \times 10^{5}$	$9{\cdot}70 \times 10^{2}$	4·584	4·576	—	$2{\cdot}80 \times 10^{2}$	0·473
120	55	40	$2{\cdot}42 \times 10^{5}$	$2{\cdot}42 \times 10^{5}$	$7{\cdot}60 \times 10^{2}$	4·531	4·509	—	$1{\cdot}40 \times 10^{2}$	0·472

$\cos \Phi = 0{\cdot}9063$ for Models 1, 2, 3

Note: Φ is the angle between B_o and the negative direction of the z-axis in the northern hemisphere.

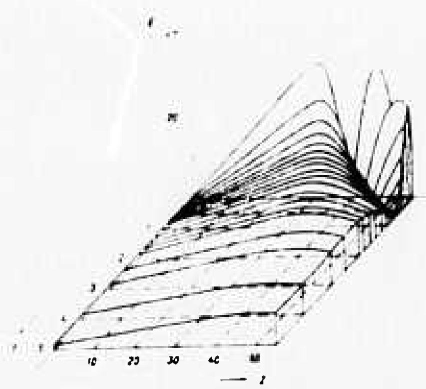


Fig. 1a. Amplitude of the electric field of a clockwise HM-wave vs. period T and co-ordinate z. T [s] $= 2\pi/\omega$, height above Earth's surface h [km] $= z + 65$. Computed for model 1.

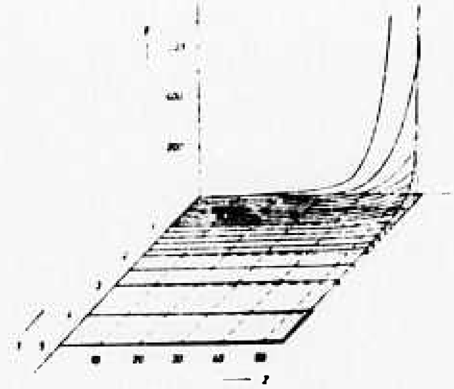


Fig. 1b. Amplitude of the electric field of a counterclockwise HM-wave vs. period T and co-ordinate z. T [s] $= 2\pi/\omega$, height above Earth's surface h [km] $= z + 65$. Computed for model 1.

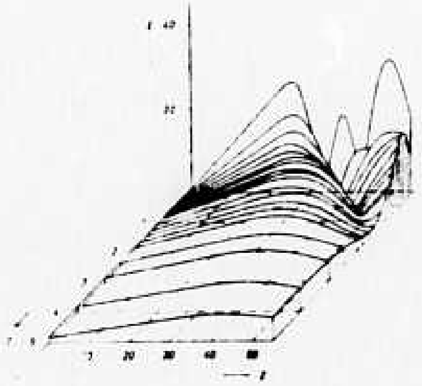


Fig. 2a. Amplitude of the electric field of a clockwise HM-wave vs. period T and co-ordinate z. T [s] $= 2\pi/\omega$, height above Earth's surface h [km] $= z + 65$. Computed for model 2.

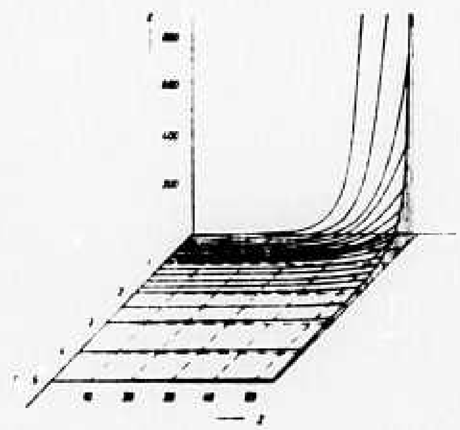


Fig. 2b. Amplitude of the electric field of a counterclockwise HM-wave vs. period T and co-ordinate z. T [s] $= 2\pi/\omega$, height above Earth's surface h [km] $= z + 65$. Computed for model 2.

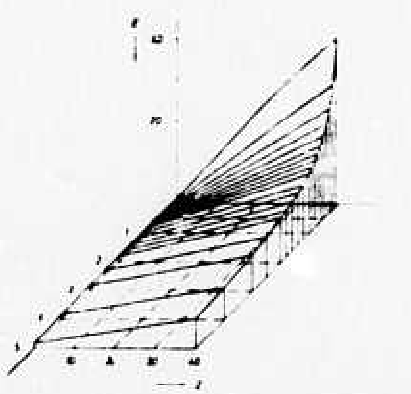


Fig. 3a. Amplitude of the electric field of a clockwise HM-wave vs. period T and co-ordinate z. T [s] $= 2\pi/\omega$, height above Earth's surface h [km] $= z + 80$. Computed for model 3.

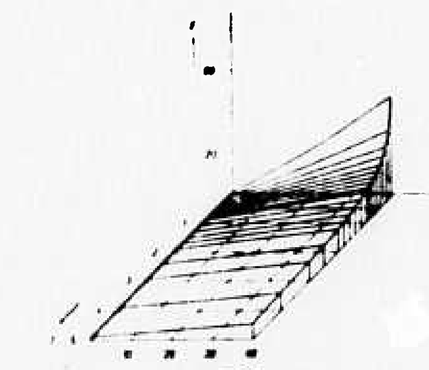


Fig. 3b. Amplitude of the electric field of a counterclockwise HM-wave vs. period T and co-ordinate z. T [s] $= 2\pi/\omega$, height above Earth's surface h [km] $= z + 80$. Computed for model 3.

Zelenkov, V. Ye. Parameters of ionospheric inhomogeneities and geoelectromagnetic field variations. IN: Sb. Ionosfern. issledovaniya, no. 21. Moskva, Izd-vo Nauka, 1972, 26-33. (RZhGeofiz, 5/73, no. 5A181). (Translation)

Relationships are investigated of the following, as a function of the magnetic activity of drift velocities and parameters of inhomogeneities: the speed of chaotic variability, the degree of elongation, orientation, lifetime, dimensions, electron density fluctuations, and the turbidity level of the ionosphere. The natural drift rate in the lower part of the F-region (up to 250 km) does not depend on magnetic activity. With an increase of magnetic disturbances, ionospheric instabilities become less in dimension and more intensive in ionization density fluctuations. They tend to orient along force lines, and their forms elongate; the chaotic variation rate of the fine ionosphere structure increases and instability lifetime shortens. Radiowave scattering becomes greater in such inhomogeneities. One similarity of all types of geoelectromagnetic micropulsations was found to be the amplitude fading of reflected waves. A comparison between simultaneous recordings of micropulsations and r-f fading gave the best coincidence for fluctuation periods during reflections from the E-layer, and also for periodic and quasiperiodic fading reflections in the F-regions.

Zagulyayeva, V. A., and A. A. Kashin. The relation of horizontal component variations of geomagnetic field with drift in the ionosphere. IN: Sb. Ionosfern. issledovaniya, no. 21. Moskva, Izd-vo Nauka, 1972, 15-18. (RZhGeofiz, 5/73, no. 5A180) (Translation)

Observations were conducted of drifts in the ionosphere over Tblisi, located near the S_q-center of a current system. Variations of the east-west component of drift were compared with horizontal component variations of the geomagnetic field, and a good correlation was found between them. Correlation coefficients were 0.81 and 0.80 for the F2 and F-layer, respectively. Drift velocities calculated on the basis of measurements in the geomagnetic field were smaller by an order of magnitude than experimental figures.

Davydov, V. M. On the frequency and geometric sounding of the magnetosphere using long-period hydromagnetic pulsations. IN: Sb. Issled. po geomagnetizmy, aeron. i fiz. solntsa., no. 24. Irkutsk, 1972, 43-62. (RZhGeofiz, 5/73, no. 5A204). (Translation)

Based on calculations of the propagation of low-frequency hydromagnetic pulsations in layered media, a theory is suggested for frequency and geometric sounding of the magnetosphere. Methods are worked out for estimating longitudinal conductivity of the magnetosphere. based on cross-section relationships of pulsations recorded at magnetic conjugate points. The conductivity is estimated from experimental data of Pi 2 micropulsations. Master curves of soundings are calculated. It is asserted that the results establish a prerequisite for studying longitudinal conductivity as a function of time.

Davydov, V. M. Method of determining the longitudinal magnetospheric conductivity from type Pi2 magnetic field pulsations. DAN SSSR, no. 5, 1973, 1071-1073.

The effective conductivity, averaged along an entire Faraday tube, is calculated based on pulsations having periods from fractions to tens of minutes. The pulsations are formed by a local electric dipole source located at point $z_0 = -d$ of the magnetosphere and oriented along the x-axis, as shown in Fig. 1. The magnetosphere is filled with a

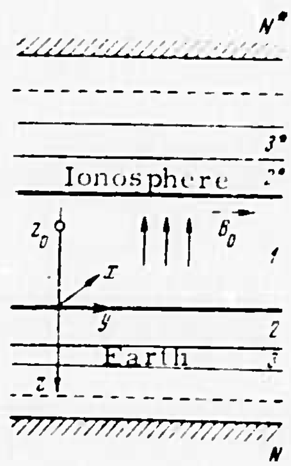


Fig. 1. Pulsation model

cold plasma with conductivity $\sigma_{\parallel}$ along the lines of force of the main geomagnetic field B^0 and with dielectric constant $\epsilon_{\perp} = 1/\mu_0 v^2$) in the perpendicular direction: here $\mu_0 = 4\pi \times 10^{-1}$ H/m, and v is Alfven velocity. The lower layers of the ionosphere are characterized by thickness h_1^0 and h_2^0 in the southern and northern hemispheres respectively, and also by Hall (σ_{xy}) and Pedersen (σ_{xx}) conductivities.

Transforming the general equation developed previously by the author and disregarding shifting currents, (conductivity is expressed as a function of pulsation area for the case of an arbitrary earth on the daytime surface ($z = h_2$). The analogous expression for the remaining hemisphere is also found.

The author notes that the area of the pulse is a more stable integral characteristic of pulsations, but this does not exclude the advantages of the proposed method of calculating $\sigma_{\parallel}$. It also follows from the derived formulas that some magnetospheric parameters may be found from the results of coordinated observations in one hemisphere, carried out along a curvilinear profile at different distances r from the source.

Konecny, M. Occurrence of Pc 1 and Pc 2 pulsations at Novolazarevskaya Station (Antarctica) and comparisons with Budkov Observatory data. IN: Geofys. sb., no. 18, 1970 (1972), 349-362. (RZhGeofiz, 5/73, no. 5A230).

Pulsations of Earth's e-m field in the period range of 0.2 to 10 sec were observed simultaneously in Novolazarevskaya (Nl) ($\Phi = 70^\circ 46' S$; $L = 11^\circ 49' E$) and in Budkov, Czechoslovakia (Bu) ($\Phi = 49^\circ 04' N$; $L = 14^\circ 01' E$), during April 1964 - February 1965. The mean daily variations of Pc 1-2 occurrences showed maxima between 16-17 hrs at Nl and 02-04 hrs at Bu, local time. The appearance of maxima in Pc 1-2 daily variations at Nl shifts from month to month over a 3-4 hour limit. Regarding seasonal variation, maximum Pc 1-2 occurs in October at Nl, and in November at Bu. The frequency spectrum of pulsations at Nl is broader than at Bu and extends to periods up to 5-6 sec, while at Bu the spectrum is limited to periods of 3-4 sec. Daily variations of pulsation periods at Nl are distinct and with minimum values in the morning and maximum in evening. At Bu, daily pulsation period variations are less distinct. Pc 1-2 appear more frequently at times of magnetically quiet conditions. Correlations between Pc 1-2 durations and magnetic activity are outlined. The total duration per day of Pc 1-2 decreases with increase in daily values of K_p. Pc 1-2 were observed simultaneously at both stations most frequently in October and November, and also at times of sudden magnetic storm and during periods of increased magnetic activity ($K_p > 2$).

Dobes, K., K. Prikner, and J. Strestik. Processing rapid variation records of the geomagnetic field by computer. Geofys. sb., no. 18, 1970(1972), 335-348. (RZh Geofiz, 5/73, no. 5A240) (Translation)

The authors discuss the fine structure of Pc 3, Pi 1, Pi 2, and Pc 1 (pearl) pulsations and SSC spectra recorded at Budkov Observatory (Czechoslovakia) during 1968-1969. The recorded rapid geomagnetic field fluctuations were processed by a method of calibrating the spectra of those fluctuations distorted by the recording apparatus. Numerical processing was done on a Minsk-22 computer. It was found that the Pc 3 type pulsation spectrum has two maxima close to one another, suggesting that the character of these pulsations is due to the superposition of two neighboring frequencies. Pi 2 pulsation spectra have one broad and a few secondary narrow maxima. During a magnetic excitation interval, Pi 1 pulsations have an extended series of maxima, distributed over a wide frequency range. Pc 1 pulsation spectra show one main maximum, followed by few secondary small ones. SSC spectra are concentrated mainly in the low frequency region. A big difference between recorded fields and natural fields is found only in the case of pulsations with a complex spectral structure (mainly for Pi-type pulsations).

Prikner, K., J. Strestik, and K. Dobes. <u>Frequency analysis of beat-type geomagnetic pulsations in the Pc3 range.</u> Studia geoph. et geod., no. 3, 1972, 262-270.

A spectral analysis of Pc3 pulsations recorded at the Budkov station was performed for June and July 1968 and 1969. The computation of spectra for 99 Pc3 events in x and y-components and 28 events in the x-component only was carried out in the 10 mHz <f< 100 m Hz range.

The daytime variation of occurrence rate of Pc3 in the x-component is shown in Fig. 1.

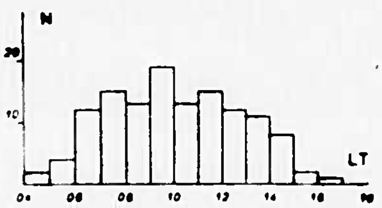


Fig. 1. Daytime occurrence rate of Pc3 in the x-component.

Examples of computed spectra are shown in Fig. 2.

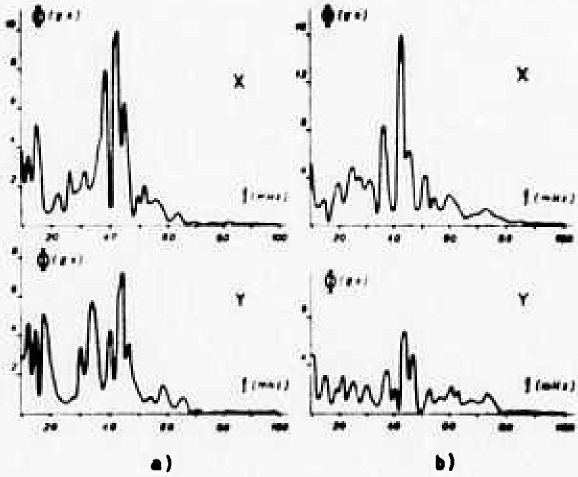


Fig. 2. Examples of Fourier spectra.
a) Pc3, July 26, 1968, 0821 LT accompanied by Pc4; b) Pc3, June 9, 1968, 0811 LT.

The cumulative occurrence rates of the fundamental frequency interval (FFI) of Pc3 pulsations are shown in Fig. 3.

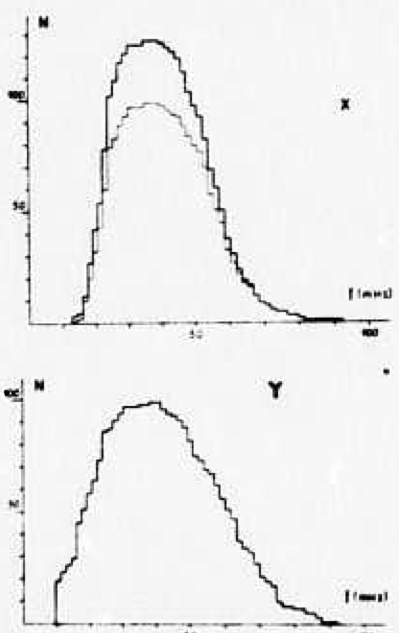


Fig. 3. Cumulative occurrence rate of FFI.

$$N(f) = \sum_i U_i(f)\,. \quad \left\{ \begin{array}{ll} U_i(f) = 1 & \text{inside the } i\text{-th FFI;} \\ U_i(f) = 0 & \text{outside the } i\text{-th FFI.} \end{array} \right.$$

The results of the analysis can be summarized as follows:

1. The average values of FFI are 22.2 mHz < f_x < 57.3 mHz and 17.5 mHz < f_y < 62.1 mHz in the x and y-components, respectively;

2. The centers of cumulative occurrence rate graphs for FFI are f_g = 41 mHz and are more or less identical in both components;

3. The central frequency f_g displays a slight tendency toward a systematic decrease from the morning to afternoon hours (see Fig. 4 and Table 1)

4. A counterclockwise polarization sense of Pc3 is predominant, particularly in the morning (see Fig. 5 and Table 2).

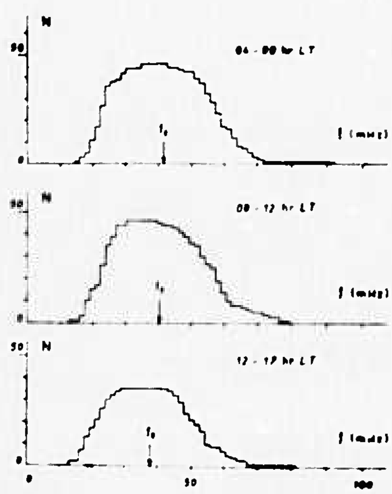


Fig. 4. Diurnal variations in cumulative occurrence rate of FFI in the x-component.

Table 1. Diurnal variations of f_g and T_g.

LT interval hrs	X-component		Y-component	
	f_{gx} mHz	T_{gx} s	f_{gy} mHz	T_{gy} s
04 09	41·6	24·0	43·5	23·0
09 12	40·7	24·6	41·4	24·2
12–17	37·6	26·8	41·4	24·2

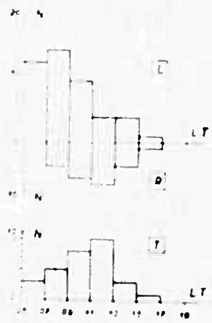


Fig. 5. Diurnal variations of the polarization sense in the x-y plane.

L - counterclockwise, R - clockwise, T - transient.

Table 2. Diurnal variations of the polarization sense.

LT interval hrs	Number of samples	L %	R %	T %
05 07	16	81·3	0	18·7
07 09	24	62·5	16·7	20·8
09 11	24	41·7	25·0	33·3
11 13	21	19·0	33·4	47·6
13 15	11	36·4	36·4	27·2
15 17	3	33·3	33·3	33·3
Sum of samples		47	22	30

Ben'kova, N. P., G. V. Bukin, A. L. Kalisher, and V. A. Troitskaya. Relationship between disturbances in the lower ionosphere and Pi 1 geomagnetic pulsations according to observations in the Arkhangelsk region in March 1968. GiA, no. 5, 1970, 842-846.

The results are described of the study of relationships between ionospheric disturbances observed at the Arkhangelsk (64.5° N, 40.3°E) and Pinega (64.5° N, 43.6° E) stations and Pil pulsations observed at Sogra (62.8° N, 46.2° E) station during March 1968.

The strong correlation revealed between the occurrence of E_s, B and Pil (SiP + AA + "noise bursts") is illustrated in tabular form. Histograms of time difference between the onsets and cessations of ionospheric disturbances and Pil show that they most frequently begin and end simultaneously. It was also found that $f_o E_s$ and the maximum amplitude of Pil pulsations correlate strongly, while h_{max} ($\approx$ 105-150 km) and the Pil maximum amplitude correlate very weakly.

The most favorable conditions for the generation of E_s and Pil were established to be at an electron density of 10^{-5} - 10^{-6} particle/ cm^3 (sic).

Afanas'yeva, L. T., and G. A. Loginov.
<u>Pc5 type geomagnetic micropulsations.</u>
GiA, no. 1, 1970, 169.

A brief analysis is given of Pc5 geomagnetic micropulsations at the Lovozero station recorded during 1962-1967. Results show that:

1) the diurnal variation of occurrence rate displays a maximum around noon;

2) the occurrence rate increases during magnetically active years;

3) the occurrence rate does not appear to be a function of season;

4) the periods of Pi2 at Lovozero satisfy the established latitude dependence;

5) Pc5 occur prior to magnetic disturbances, but do not occur if magnetic activity exceeds a certain level.

Baranskiy, L. N., P. A. Vinogradov, and O. M. Raspopov. Polarization of Pi2 type geomagnetic pulsations. GiA, no. 5, 1970, 936-938.

Polarization characteristics of Pi2 pulsations are analyzed using data from 243 events simultaneously observed at low and mid-latitudes (Sogra, Borok, Shchuchinsk, Irkutsk, and Ashkhabad) during spring of 1968, and 72 events observed simultaneously at two magnetically conjugate points (Sogra and Kerguelen).

The diurnal variation of the sense of rotation is shown in Fig. 1. The preferred directions of the major axis of the polarization ellipse for pre-midnight and post-midnight events are shown in Fig. 2

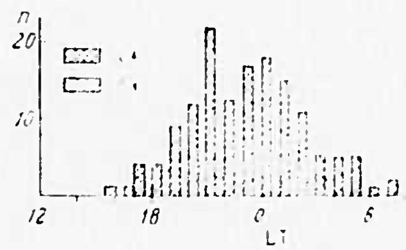


Fig. 1. Variation in rotational sense.

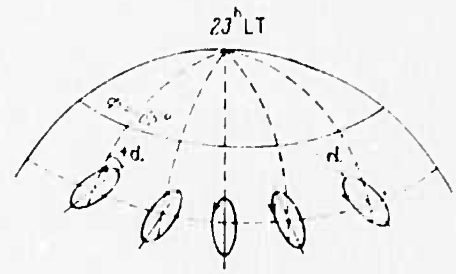


Fig. 2. Polarization ellipse major axis variation.

and Table 1 (α_1, α_2) which lists the daily average direction (α) as well.

Table 1

Station (Φ°; λ°)	α_1°	α_2°	α°
Sogra (56; 132)	+40	-17	+7
Borok (52; 120)	+ 4	- 7	-1
Shchuchinsk (44; 147)	+18	-56	-25
Irkutsk (42; 174)	+44	- 4	+14
Ashkhabad (31; 134)	+12	-26	-6

Pi2 pulsations are characterized by a reverse sense of rotation at magnetically conjugate points.

Thus on the basis of voluminous data from the stations within the 31^0-56^0 latitude range it was shown that a counterclockwise polarization of Pi2 prevails in the northern hemisphere.

Korsunova, L. P. Effect of geomagnetic excitations on the nocturnal E-region at midlatitudes. GiA, no. 5, 1973, 835-839.

An account is given of the increase in electron density in the midlatitude nocturnal E-region during magnetically disturbed periods. The effect and characteristics were estimated of an assumed additional source of ionization in the nocturnal disturbed E-region, using all available data from rocket-borne and ground-based observations (Korsunova, 1970; Maeda, 1969; Knight, 1972; Wakai, 1967; and Wakai, 1967). The observed and calculated nocturnal variations in electron density number n_e during equinoctial and winter months at K_p = 0-3 are shown in Fig. 1.

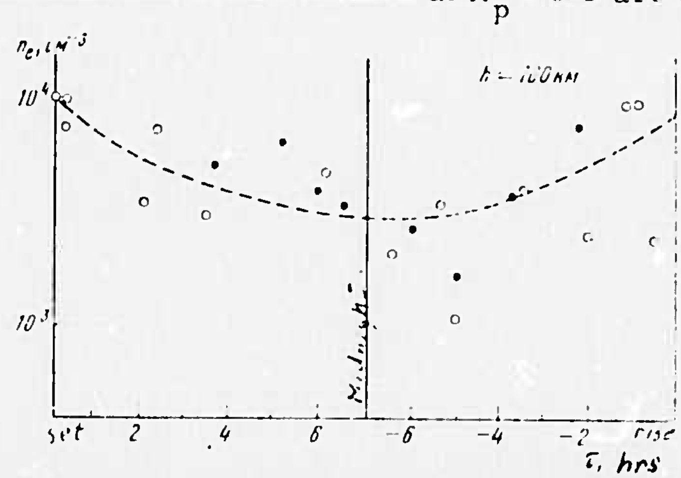


Fig. 1. Nocturnal variation in n_e.

Changes in electron density at h $\leq$ 110 km and h > 110 km of the nighttime E-region during magnetically disturbed periods are illustrated in Fig. 2, showing K_p dependence of $\Delta lgn_e = lgn_e - lgn_{e\,quiet}$ where n_e is observed and $n_{e\,quiet}$ estimated for quiet-conditions values of electron density number.

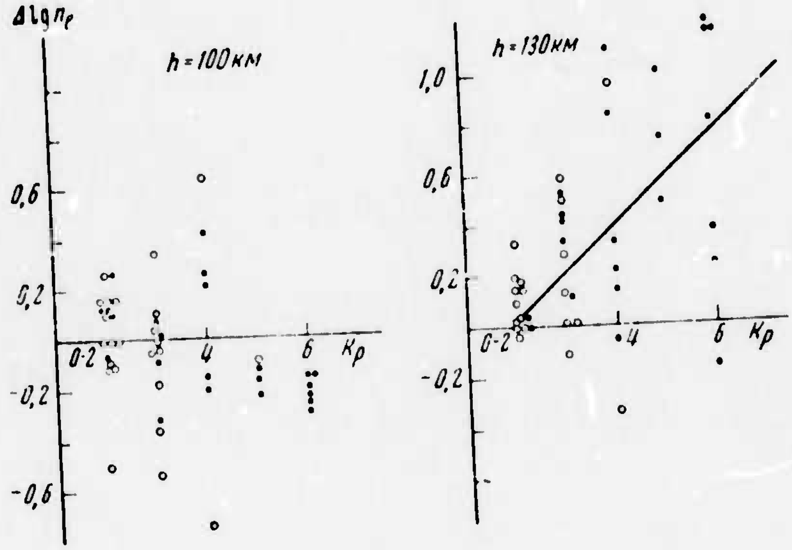


Fig. 2. $K_p (\Delta lgn_e)$

The author concludes that the observed increase in electron density at h > 110 and $k_p > 5$ does not take place due to a redistribution of electrons, but rather occurs because of an additional source of ionization (total content of electrons increases by a factor of 3 at $k_p > 5$).

The energy flux of the additional source at $3 < K_p < 6$ is estimated to be $\Delta w > 5 \times 10^{-4}$ erg/cm^2 sec, i.e. larger by a factor of 3 than that during quiet conditions. The energy of the additional source (precipitating electrons) is estimated to be 1-3 keV.

Davydov, V. M. Propagation of low-frequency hydromagnetic pulsations in the case of non-orthogonal field lines of the main geomagnetic field. IN: Issledovaniya po geomagnetizmu, aeronomii i fizike solntsa, no. 23, 1972, 217-224.

The problem indicated in the title is stated and expressions for the complex amplitudes of electric and magnetic fields are derived for all layers of the model. The model considered is shown in Fig. 1.

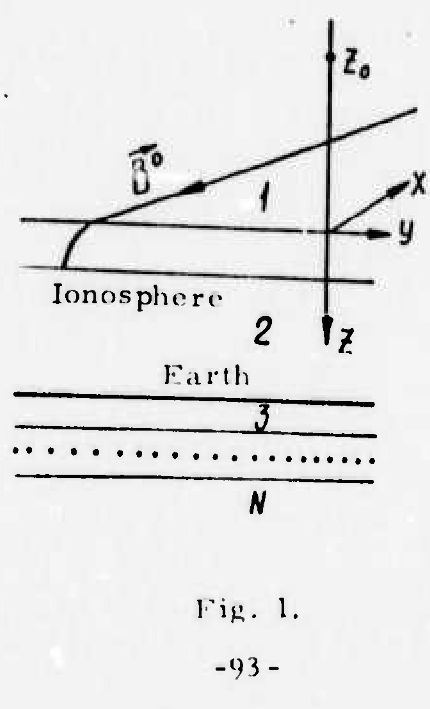


Fig. 1.

The magnetosphere is assumed separated from the atmosphere 2 by a thin gyrotropic layer modeling the lower ionosphere.

Aleksandrov, A. P., L. L. Van'yan, V. I. Dmitriyev, and A. A. Kozhevnikov. Propagation of directional hydromagnetic waves in a plasma magnetized by a curvilinear field. IN: Issledovaniya po geomagnetizmu, aeronomii i fizike solntsa, no. 24, 1972, 30-36.

The propagation of low-frequency hydromagnetic waves in a plasma permeated by a curvilinear magnetic field, and the associated electric currents, are considered. The cases of excitation of h-m waves both by infinite and finite dipoles (Figs. 1 and 2, respectively) are considered.

It was found that directed h-m waves alternate with increase of R (decrease of curvature) as $1/\sqrt{R}$. An important characteristics of the propagation of h-m waves through a plasma permeated by a curvilinear magnetic field is an inductive excitation of those field force lines whose radii satisfy the condition $kR = h$ where $h = 1, 2, 3, \ldots$.

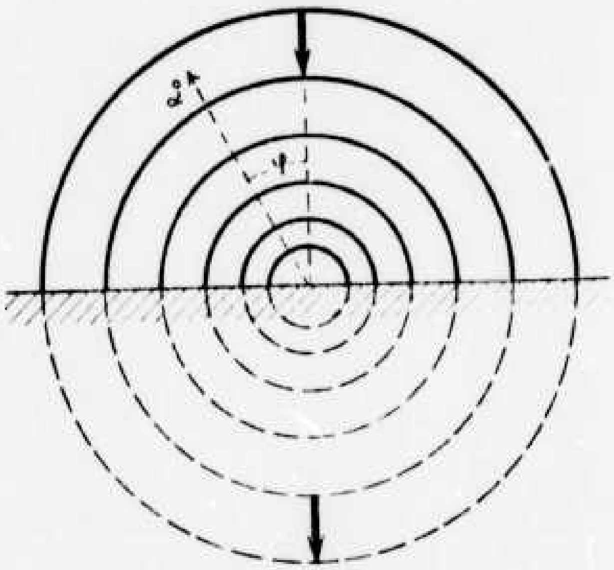


Fig. 1. Configuration of magnetic field and emitting dipole with its image.

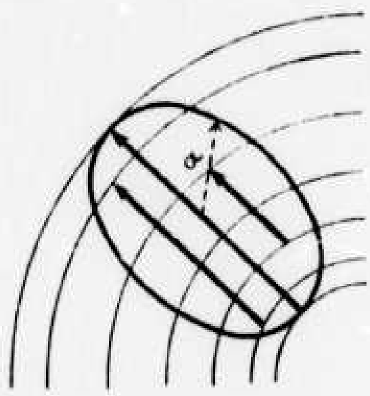


Fig. 2. Cross section of finite source.

Mal'tseva, N. F., and V. P. Selivanov. Analysis of dynamic spectra of IPDP's recorded simultaneously at a longitudinal chain of observatories. GiA, no. 3, 1972, 575-578.

An analysis is given of IPDP's observed simultaneously at the Lovozero, Borok and Ashkhabad stations during the period 1961-1967.

The average differential frequencies for IPDP's simultaneously observed at Lovozero and Borok as well as at Irkutsk and Borok (i.e. widely spaced in longitude) are listed in Table 1. Dynamic spectra for

Table 1

Date	Δf_{I-B}, Hz	Δf_{B-L}, Hz	Date	Δf_{I-B}, Hz	Δf_{B-L}, Hz
1/18/61	0.37	+0.04	1/2/64	0.38	-0.03
1/25/61	0.31	+0.18	1/18/64	0.43	+0.07
2/3/61	0.35	+0.09	12/16/64	0.24	-0.06
2/4/61	0.36	+0.01	3/3/65	0.08	+0.02
2/20/61	0.06	-0.08	10/2/65	0.33	+0.09
3/27/61	0.18	-0.09	10/30/65	0.11	-0.14
9/11/61	0.17	+0.00	1/21/66	0.17	-0.06
3/6/62	0.53	+0.11	1/22/66	0.05	+0.07
10/21/62	0.30	-0.04	2/11/66	0.36	-0.01
10/24/63	0.35	-0.04	1/7/67	0.43	-0.04

IPDP's simultaneously observed at Lovozero and Borok are shown in Fig. 1.

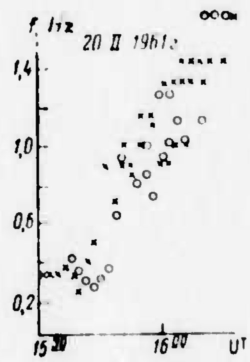


Fig. 1. IPDP Spectra.
o- Lovozero
x- Borok

The amplitude characteristics of the IPDP's at Lovozero and Borok are as follows: H_L - 130 and 200 $m\gamma$, H_B - 110 and 120 $m\gamma$; $H_L/H_B \approx 0.35 - 1.99$ and $0.8 - 3.03$, for the 1- and 0.33 Hz components, respectively.

Concerning the IPDP's observed simultaneously at Borok and Ashkhabad, it was found that:

a. IPDP's at Ashkhabad begin simultaneously or later and end simultaneously or sooner than at Borok;

b. the highest and lowest frequencies are, as a rule, absent at Ashkhabad;

c. in the case of a full "passage" the dynamic spectra are similar (see Fig. 2)

d. the amplitudes of the 1- and 0.5 Hz components are 5-10 times less at Ashkhabad.

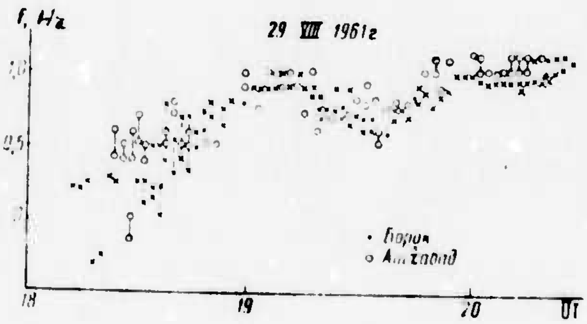


Fig. 2. IPDP Spectra.

x- Borok
o- Ashkhabad

Bonska, J. The pulsation activity of a geomagnetic storm. Studia geoph. et geod., no. 1, 1973, 22-26.

A review is given of the results of the studies of micropulsation activity at various midlatitude observatories during geomagnetic storms. The results are summarized in the following table.

Table 1.

Period	Phase	Pulsation type	Characteristics	Notes
Pre-storm events	*sfe*	*pi2*	$T \sim 40$ to 100 s $A \sim 1$ to 2γ	Occurrence during increase in *H*; in special cases the amplitudes may be larger
		pc3	$T \sim 20$ s $A \approx 0.4\gamma$	
	between *sfe* and *ssc*	*pc1*	$T \sim 2$ s $A \approx 0.05\gamma$	"Pearls" sometimes occur several hours prior to *ssc* during magnetically calm intervals
		pc4	$T \sim 50$ to 60 s $A \approx 2\gamma$	
Storm time	*ssc*	*pc1*	$T \sim 1$ to 3 s	Frequently superimposed on pulsations with longer periods
		pc2,3	$T \sim 5$ to 32 s $A \approx 0.5\gamma$	
		Bpc	*T* like *pc3*	Amplitude modulation
		pi2	$T \sim 120$ s $A < 3\gamma$	Depends on intensity of bay, time of day, solar cycle; occur particularly at sunrise and sunset
	IP	*pc2,3*	$T \sim$ [illegible] to 18 s	Shorter periods, 80% of all *pc*'s
		pi1	*T* most frequently around 10 s	Most frequent of all types of pulsations other types of pulsations only rarely
	MP	*pc1*	$T \sim 1$ to 2 s	Rarely a pure type, period changes; shifts in times of max. occurrence
		pi1	$T \approx 20$ s	
		pc1 + pi1	$T \sim 1$ to 4 s	Occur most frequently; variable periods; associated with aurorae
		pi2	$T \approx 120$ s	Periods decrease in intervals with larger *Kp*'s
		IPDP	$T \sim 10$ to 0.3 s	Most typical for *MP*
		pc3	$T \sim 12$ to 34 s $A \approx 0.3\gamma$	Decrease in *T* in dependence on *Kp*; decrease of *A* as a storm-time effect
		Bpc	*T* like *pc3*	Changes in beat and pulse periods
		pc4,5	$T < 300$ s *A* a few γ	*T* larger in intervals with higher *Kp*; superposition of *pc1*'s
	RP	*pc1*	$T \sim 1$ to 2 s	
		pc3	$T \sim 10$ to 45 s $A \approx 0.6\gamma$	Transition to usual diurnal occurrence
		Bpc	*T* like *pc3*	Increase in beat and pulse periods
Post-storm events	calm interval after *RP*	*pc1*	*T* most frequently 1 to 2 s	Large frequeney for a period of several days in mid-latitudes usually at night Occurrence of pulsation types typical for calm preiod

Kiziriya, L. V. On the polarization character of Pi2 geomagnetic pulsations. IN: Tr. In-t geofiz. AN GruzSSR, no. 28, 1972, 64-69. (RZhGeofiz, 3/73, no. 3A271) (Translation)

Rotational direction and direction of the polarization ellipse major axis was studied for Pi2 micropulsations, from data recorded at the Dusheti, Sogra and Lovozero Stations. The predominant rotation (~75% of the cases) is counterclockwise. No daily tendency toward rotational shift was observed. The mean azimuth direction of major axis polarization was found to be (-)5^{o} at Dusheti, +25^{o} at Sogra, and (-)46^{o} at Lovozero; the direction at Dusheti was perpendicular to the cismontane strike structure of the greater Caucasus. The mean midday polarization characteristics at Dusheti was typical for midlatitude stations, i.e., the direction is easterly in morning hours and westerly in evening hours, relative to mean daily direction. In Sogra and Lovozero the daily polarization characteristics are somewhat different, which may be ascribed to the higher latitude of these stations.

Dobes, K., K. Prikner, and J. Strestik.
Frequency - direction analysis of geomagnetic pulsations. Part I. The method. IN: Studia geoph. et geod., 3, 1973, 240-244.

A new method is described of the computer processing of geomagnetic micropulsations based on the spectral analysis of the amplitude time records in two perpendicular components. The method uses calculation of the amplitude spectra of a Pc event in any direction on the X Y-plane (or XZ and YZ) and thus provides for its frequency-direction display. The computation procedure also enables the determination of the distribution of energy in geomagnetic micropulsations over the XY plane and the polarization characteristics of individual frequency components.

The amplitude spectrum in the direction which makes an angle ψ with the x-axis is given by

$$\begin{aligned}\Phi_\psi(f) = \big[&(A_x^2 + B_x^2)\cos^2\psi + (A_y^2 + B_y^2)\sin^2\psi + \\ &+ 2(A_x A_y + B_x B_y)\sin\psi\cos\psi\big]^{1/2},\end{aligned} \qquad (1)$$

where

$$\begin{aligned} A_x(f) &= \pi^{-1}\int_0^T x(t)\cos 2\pi f t\,dt, & B_x(f) &= \pi^{-1}\int_0^T x(t)\sin 2\pi f t\,dt, \\ A_y(f) &= \pi^{-1}\int_0^T y(t)\cos 2\pi f t\,dt, & B_y(f) &= \pi^{-1}\int_0^T y(t)\sin 2\pi f t\,dt, \end{aligned} \qquad (2)$$

where T is the length of the event; x(t) and y(t) are the records of the event in the x- and y- components, respectively.

Examples of calculated spectra are shown in Fig. 1.

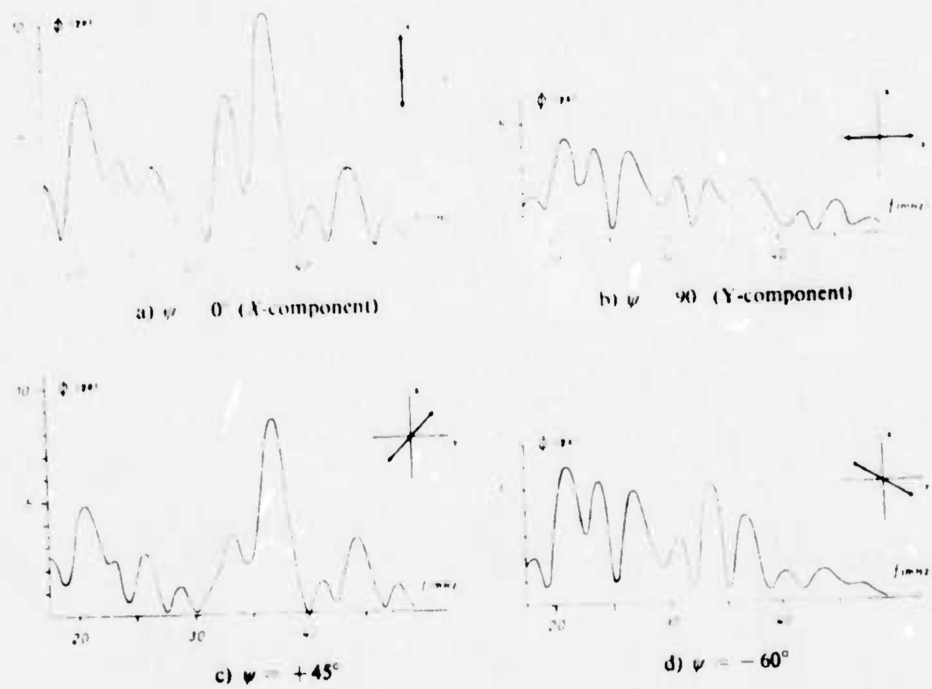


Fig. 1. Fourier spectra of Pc3 pulsations observed at the Budkov station ($\Phi = 49^{o}02'$, $\lambda = 96^{o}02'$) on July 30, 1968.

The frequency-direction display of the calculated spectra is shown in Fig. 2.

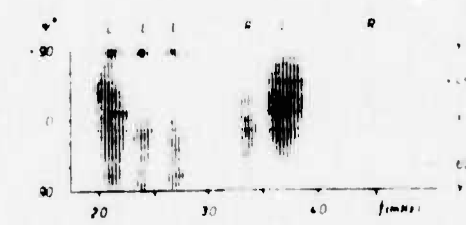


Fig. 2. Frequency-direction display of the same event as in Fig. 1.

Fig. 3. Polarization characteristics of the same event as in Fig. 1.

thick line - θ (f); dashed line - α(f); thin line - normalized Φ_I^2 (f).

Dobes, K., J. Strestik, and K. Prikner.

Numerical calculations of frequency-time displays using amplitude-time records.

Studia geoph. et geod., no. 3/4, 1971, 331-339.

A method is presented for computation of sonagrams using amplitude-time records of geomagnetic pulsations. The results are discussed of the calculation of sonagrams from amplitude-time records of various types of geomagnetic pulsations observed at the Budkov station (Φ = 49°01', λ = 96°02') in 1968-1969.

The method is based on the computation of the complex running frequency spectrum of an amplitude-time record of the signal f(t') by formula

$$S_t(\omega) = \int_{w}^{t} g(t' - t)\, f(t') \exp(-i\omega t')\, dt' . \qquad (1)$$

where $g(t'-t)$ is an arbitrary weighting function and w is the width of the moving window as shown in Fig. 1. The real amplitude of the

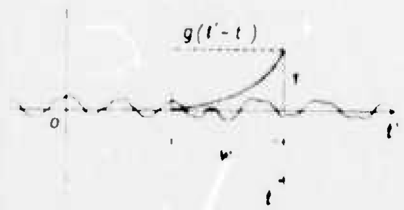


Fig. 1. Definition of the weighting function $g(t' - t)$. The full line indicates the exponential window, the dashed line the rectangular window. The quantity w is the width of the window.

complex frequency spectrum defined above is modified by an amplitude calibration curve $\epsilon(\omega)$ (or frequency filter) of the recording instrument as

$$\Phi(\omega, t) = \epsilon(\omega)\, |S_t(\omega)| , \qquad (2)$$

The amplitude of this frequency spectrum is printed as a standard sonagram.

The sonagrams calculated with different parameters for a beat-type Pc3 pulsation event (see Fig. 2) are shown in Fig. 3. An analysis shows that the best results are obtained if sonagrams are computed with a rectangular weighting function, $w = 3$ min or $w = 5\,\Delta t$.

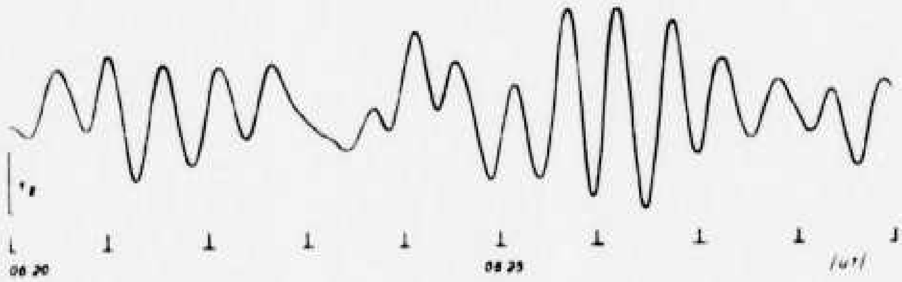


Fig. 2. Amplitude-time record of beat-type Pc3 pulsations (Sept. 15, 1968, x - component)

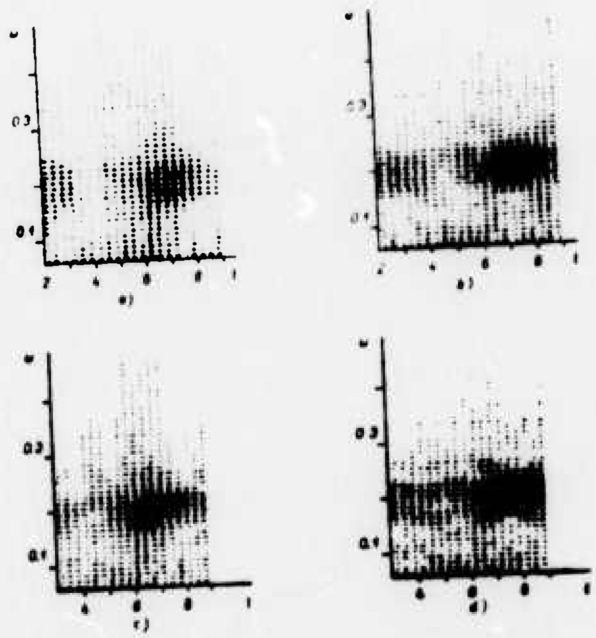


Fig. 3. Sonagrams of beat-type Pc3 pulsations from Fig. 2.

a) exponential window, w = 2 min; b) rectangular window, w = 2 min; c) exponential window, w = 3 min; d) rectangular window, w = 3 min. Time t in minutes, ω in rad/sec, as in Figs. 4-6.

Examples of sonagrams calculated for beat-type Pc3, Pc2, Pi1 and Pc1 pulsations are shown in Figs. 4-7, respectively.

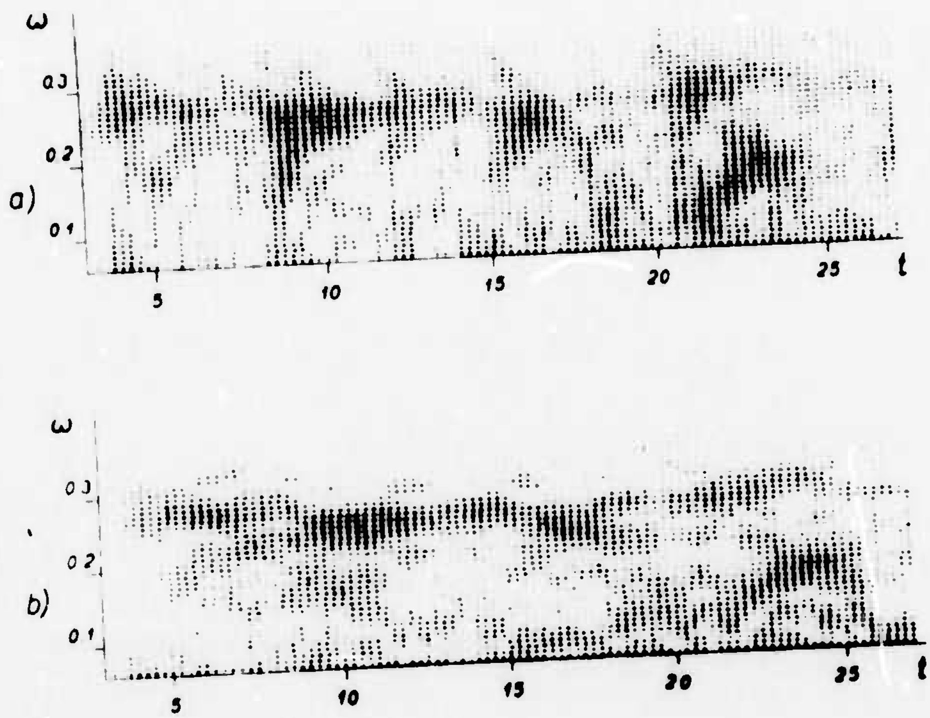


Fig. 4. Sonagram of beat-type Pc3 pulsations (Sept. 4, 1968, x - component).

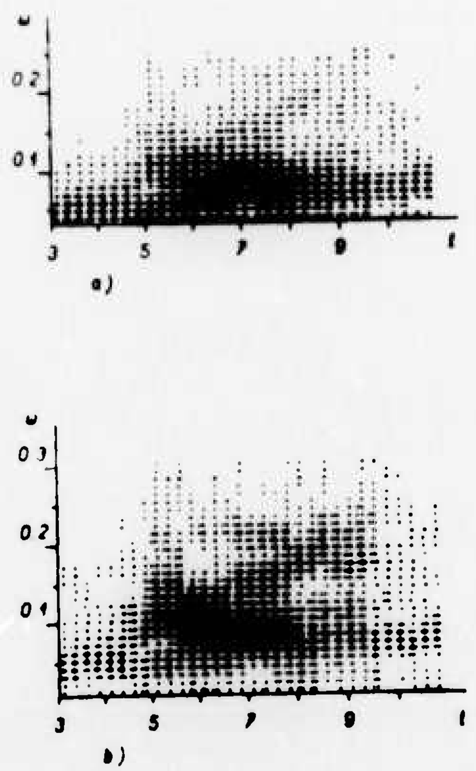


Fig. 5. Sonagram of Pi2 pulsations (Sept. 20, 1968, x - component), calculated with rectangular window and w = 3 min.

a) with the frequency response of the instrument; b) with a suitable frequency filter.

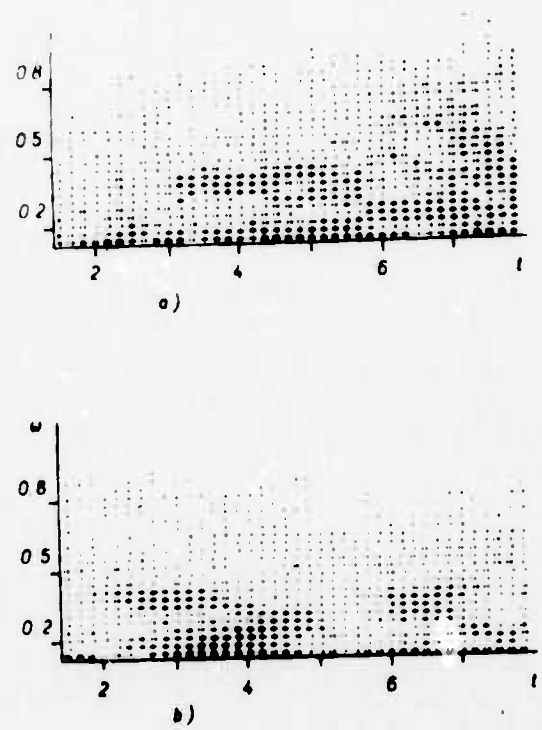


Fig. 6. Sonagram of Pil pulsations (Sept. 13, 1968, x - component) calculated with rectangular window, w = 90 sec.

a) 1147-1155 UT; b) 1153-1201 UT.

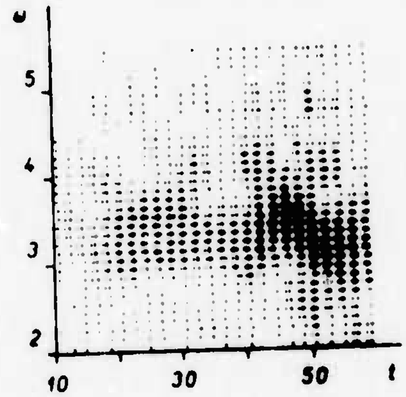


Fig. 7. Sonagram of Pc1 pulsations (Sept. 11, 1969, NS- component), calculated with rectangular window, w = 10 sec. Time t in seconds.

Mal'tsev, Yu. P. Resonant oscillations of the magnetosphere. IN: Sb. Morfol. i. fiz, polyarn, ionosfery. Leningrad, Izd-vo nauka, 1971, 75-79. (RZhGeofiz, 3/72, no. 3A310) (Translation)

The behavior of magnetospheric resonance oscillations which have an arbitrary value of azimuthal wave number m is investigated. It is shown that the dependence of the pulsation period on the geomagnetic envelope results in the fact that the oscillations eventually acquire character-istics (frequency and polarization) of a toroidal mode independent of longitude. If the period of toroidal oscillations T is proportional to R^N, where R is the geocentric distance to the most distant point of the force lines, the number of periods typical for this transient process is approximately equal to $m/2\pi N$.

Strestik, J., K. Prikner, and K. Dobes. <u>Daily variation in parameters of beat-type Pc3 (BPc3) pulsations</u>. Studia geoph. et geod, no. 1, 1973, 27-35.

This continues the analysis of the preceding paper on diurnal variations in frequency, amplitude and polarization of beat-type Pc3 pulsations at the Budkov station ($\Phi = 49^{o}01'$, $\lambda = 96^{o}02'$, LT = UT + 7h) measured during June and July 1968 and 1969. The analysis was performed using data on the frequency f_o and amplitude A_o corresponding to the main peaks of the amplitude spectra computed for nearly 100 BPc3 events in x and y components.

The diurnal histogram of the occurrence rate and examples of amplitude spectra for BPc3 events analyzed are shown in Figs. 1 and 2 respectively.

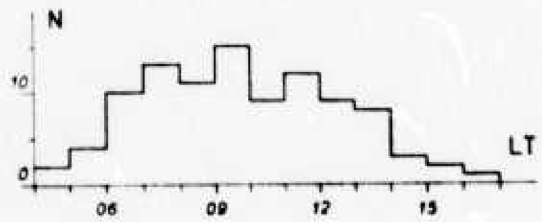
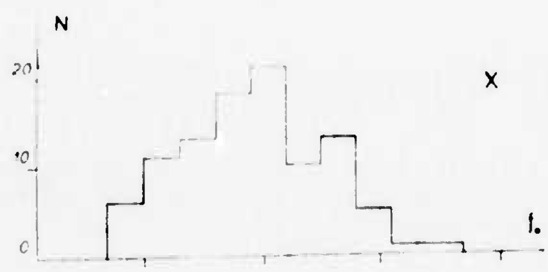


Fig. 1. Diurnal histogram of BPC3 occurrence.

The histograms of frequency f_0 of x and y component are given in Fig. 3.



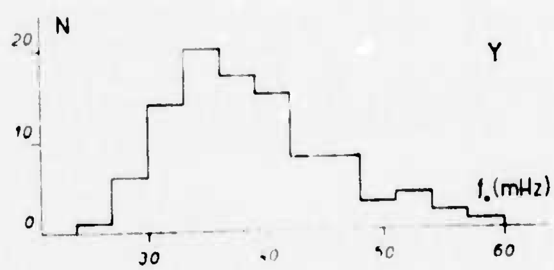


Fig. 3. Histograms of frequency f_0 for BPc3 events.

The relationship between frequencies f_{ox} and f_{oy} (in the x and y components, respectively) is shown in Fig. 4.

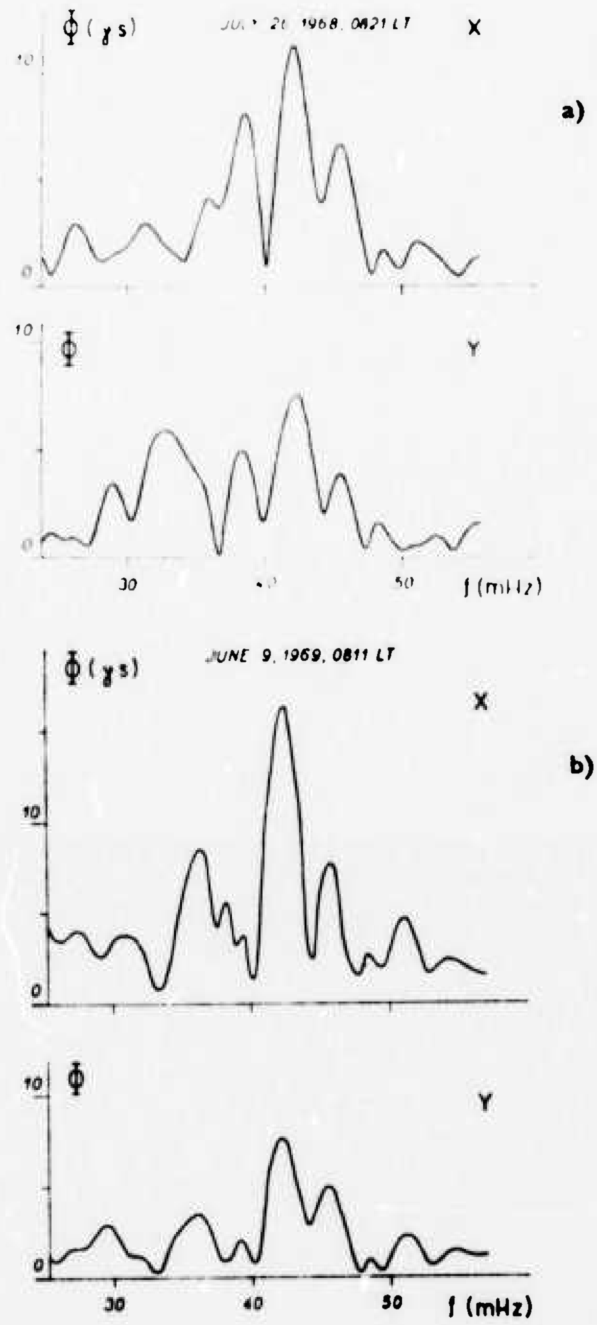


Fig. 2. Examples of Fourier spectra for BPc3 pulsations.

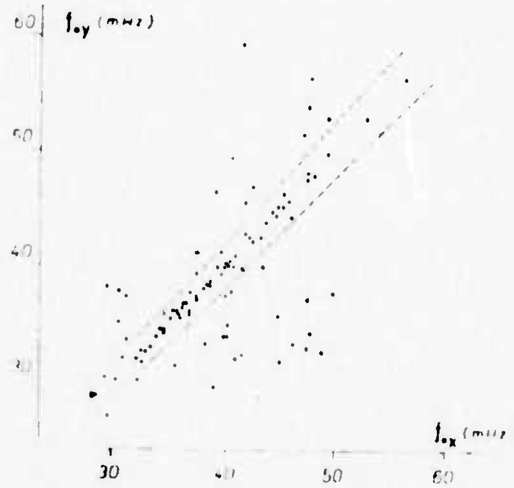


Fig. 4. Correlation between f_{0X} and f_{0Y}. The dashed lines delimit the $\pm 5\%$ deviation zone in the direction of both axes.

Analysis of the frequency and amplitude data on BPc3 events show:

1. The diurnal variation of frequency f_o (see Fig. 5) is

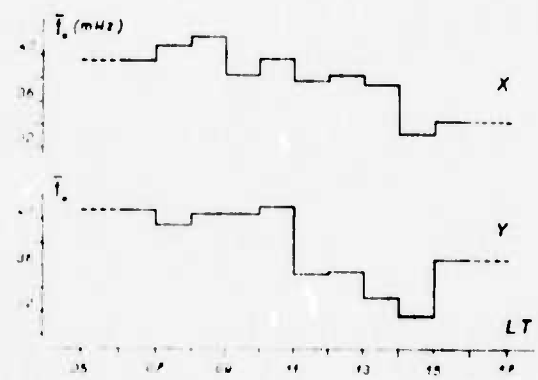


Fig. 5. Diurnal variation of frequencies f_{ox} and f_{oy}.

characterized by a steady decrease throughout the daytime hours. It depends on k-index as illustrated in Table 1.

Table 1. Dependence of the diurnal variation of f_o on k-index.

K	average f_{0x} [mHz]			N	daily average	
	04–09 LT	09–12 LT	12–17 LT		f_{0x} [mHz]	f_{0y} [mHz]
1–2	41·8	39·1	38·9	66	39·9	39·3
3–4	36·9	39·5	34·5	33	37·4	38·0

2. The diurnal variation of amplitude A_o (see Fig. 6) is

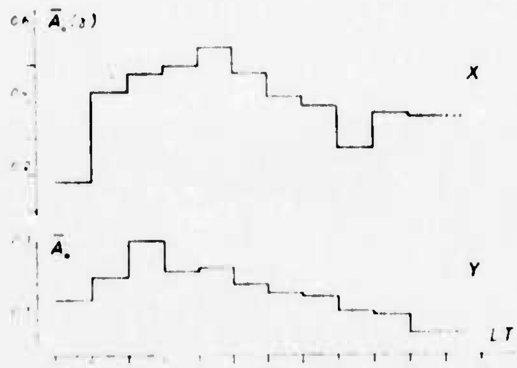


Fig. 6. Diurnal variation of amplitudes A_{ox} and A_{oy}.

characterized by a maximum at 0700-1000 LT. It does not depend on k-index, as shown in Table 2.

Table 2. Dependence of the diurnal variation of A_0 on k-index.

K	average A_{0X} [γ]			N	daily average	
	04–09 LT	09–12 LT	12–17 LT		A_{0X} [γ]	A_{0Y} [γ]
1–2	0·342	0·421	0·255	66	0·364	0·166
3–4	0·676	0·698	0·444	33	0·535	0·247

3. The diurnal variation of the ellipticity of the polarization ellipse in the x-y plane (see Fig. 7) is characterized by a steady decrease

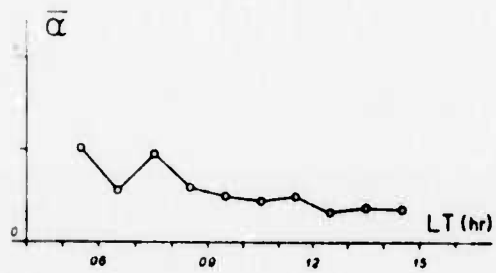


Fig. 7. Diurnal variation in ellipticity α of the polarization ellipse.

throughout the daytime hours. The preferential direction of the major axis of the polarization ellipse is north-south. The diurnal variation in the sense of rotation of the disturbance vector of the f_0 components is similar to that of the total disturbance vector as reported by Prikner et al. in the foregoing paper.

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